Module 4

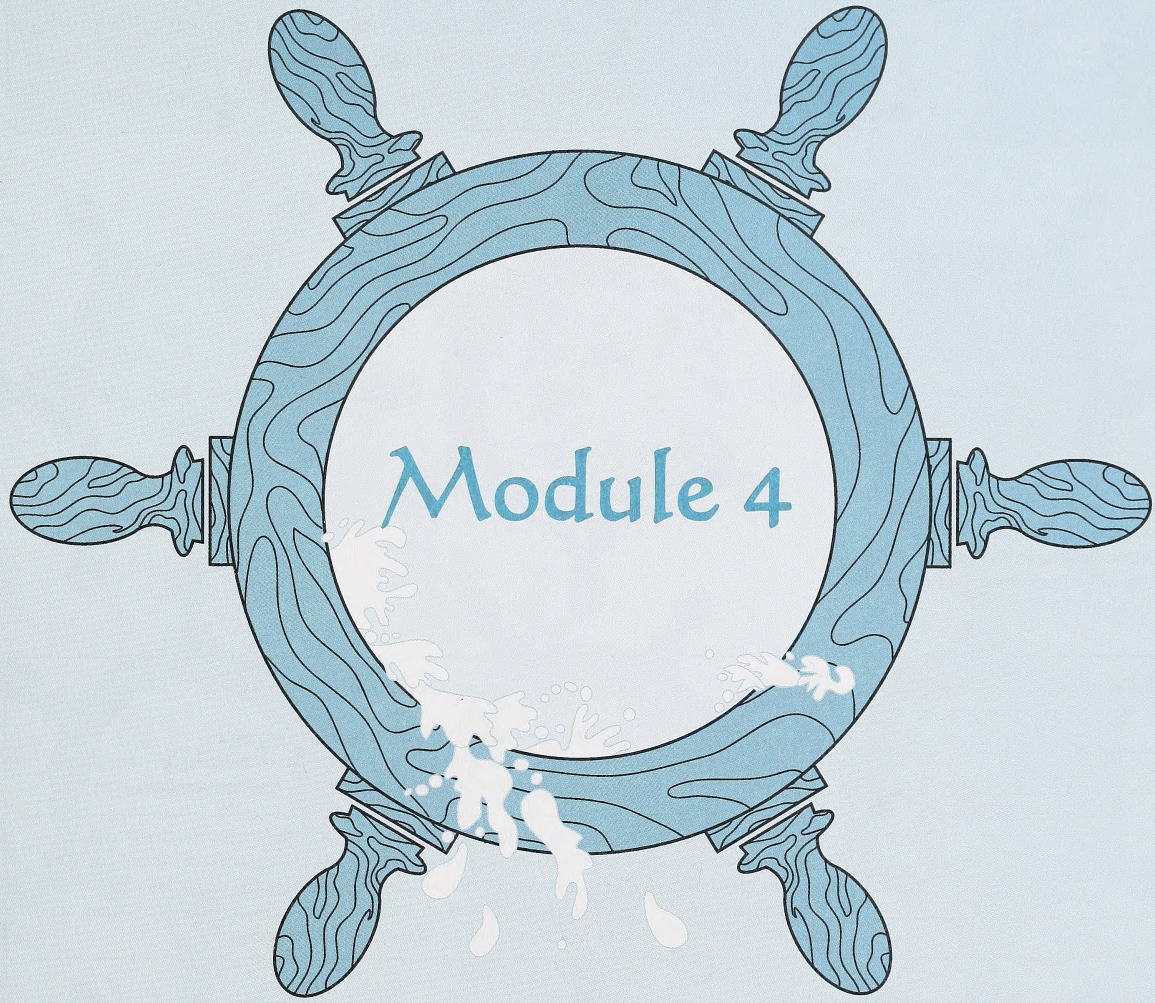
Mathematics 5

Transformations

Learning Technologies Branch

Alberta LEARNING

Mathematics 5



Transformations

Learning Technologies Branch

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LEARNING

Mathematics 5
Module 4: Transformations
Student Module Booklet
Learning Technologies Branch
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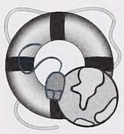
This document is intended for	
Students	✓
Teachers	✓
Administrators	
Home Instructors	
General Public	
Other	



You may find the following Internet sites useful:

- Alberta Learning, **http://www.learning.gov.ab.ca**
- Learning Technologies Branch, **http://www.learning.gov.ab.ca/ltb**
- Learning Resources Centre, **http://www.lrc.learning.gov.ab.ca**

The use of the Internet is optional. Exploring the electronic information superhighway can be educational and entertaining. However, be aware that these computer networks are not censored. Students may unintentionally or purposely find articles on the Internet that may be offensive or inappropriate. As well, the sources of information are not always cited and the content may not be accurate. Therefore, students may wish to confirm facts with a second source.

Welcome Aboard
Mathematics 5

Ahoy! Mathematics 5 contains nine modules.
You should work through the modules in order (from 1 to 9) because concepts and skills introduced in one module will be reinforced, extended, and applied in later modules.

Adventures on the High Seas

Kassidy: Connor, guess what? I noticed an advertisement in the newspaper. A second-hand bookshop just opened, and it's supposed to have some really old books from all over the world.

Connor: Some may even be older than our great-grandparents! Let's go take a look.

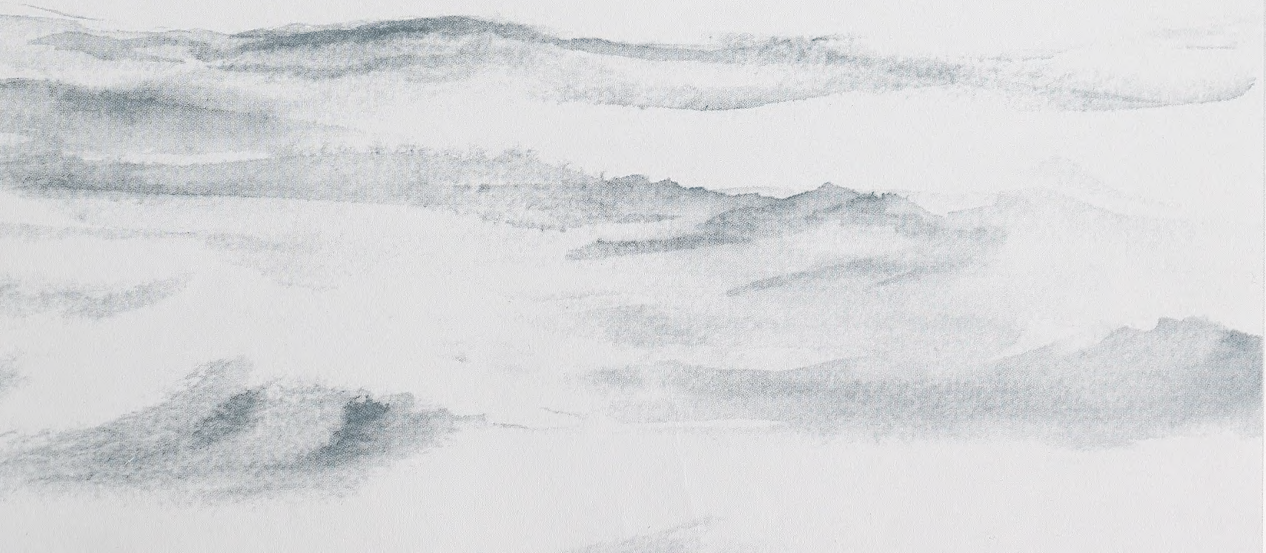
Excited about what they might find to read, Connor and Kassidy hurry off to the bookshop.

Connor: Wow! Look at this, Kassidy. Here's an actual journal kept by Captain Quinn almost 300 years ago. It's kind of musty, and parts are hard to read, but look at how much math the captain used!

Kassidy: There are also maps, descriptions of ships, and reports about sea conditions.

Connor: Let's buy it. Figuring out what the journal says will be like unravelling a mystery. Maybe it will have clues about real buried treasure.

From time to time throughout the course, you will work with many of the facts and figures about the days of sailing boats and sea captains that Kassidy and Connor discover.



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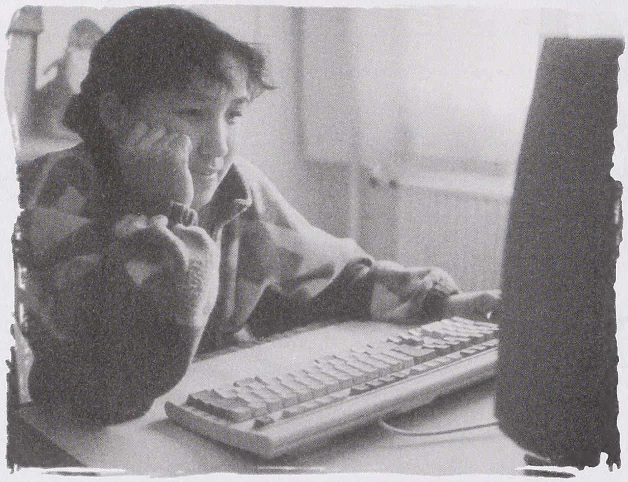
Course Features



BRYAN AND CHERRY ALEXANDER PHOTOGRAPHY

Take the time to look through the Student Module Booklet and the Assignment Booklets and notice the following design features.

- Each module has a Module Overview, Module Summary, and Review.
- Each module has several lessons. Each lesson focuses on a big idea that is central to the topic being learned in the module.
- Each lesson has several activities. An activity in each lesson is related to the high seas adventure theme. The last activity in each lesson is a Challenge Activity.
- Each module has a Glossary and an Answer Key in the Appendix. In several modules there are also special pull-out pages in the Appendix.
- Each module has special exercises that focus on certain mathematical skills. For example, The Numbers in the News project involves a scavenger hunt for samples of math in everyday life. The Keystrokes exercise introduces some "funky features" of the calculator that can be used to explore and practise important number ideas.

Required Resources

There are no spaces provided in the Student Module Booklets for your answers. This means you will need a binder and loose-leaf paper or a notebook to do your work.

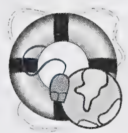
In order to complete the course, you will need a copy of the Mathematics 5 textbook, *Quest 2000: Exploring Mathematics*, the soft-cover book *Quest 2000: Exploring Mathematics: Practice and Homework Book*, a basic four-operation calculator (such as the TI-108 calculator), and various manipulatives (base ten blocks and pattern blocks).

If you wish to complete the optional computer activities, you must have access to a computer that is connected to the Internet.

Visual Cues

For your convenience, the most important mathematical rules and definitions are highlighted. Icons are also used as visual cues. Each icon tells you to do something.

Use your calculator.



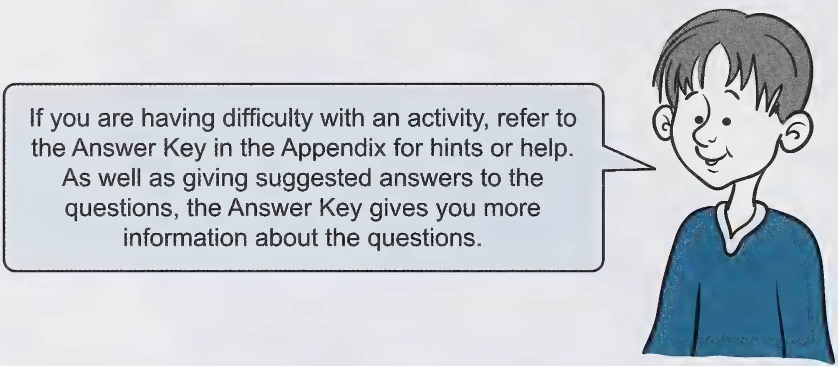
Use the Internet.

Refer to the textbook or the Practice and Homework Book.

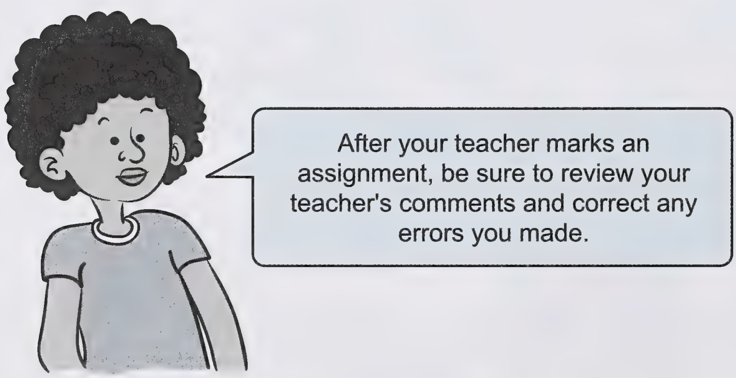
Your guides for this course are Kassidy and Connor.

Assessment and Feedback

The Mathematics 5 course is carefully designed to give you many opportunities to discover how well you are doing. In every activity you will be asked to turn to the Appendix to check your answers. Completing the activities and comparing your answers to the suggested answers in the Appendix will help you better understand math concepts, develop math skills, and improve your ability to communicate mathematically and solve problems.



Twice in each module you will be asked to give your teacher your completed assigments to mark. Your teacher will give you feedback on how you are doing.



There will be a final test at the end of the course. You can prepare for the final test by completing the Review at the end of each module.

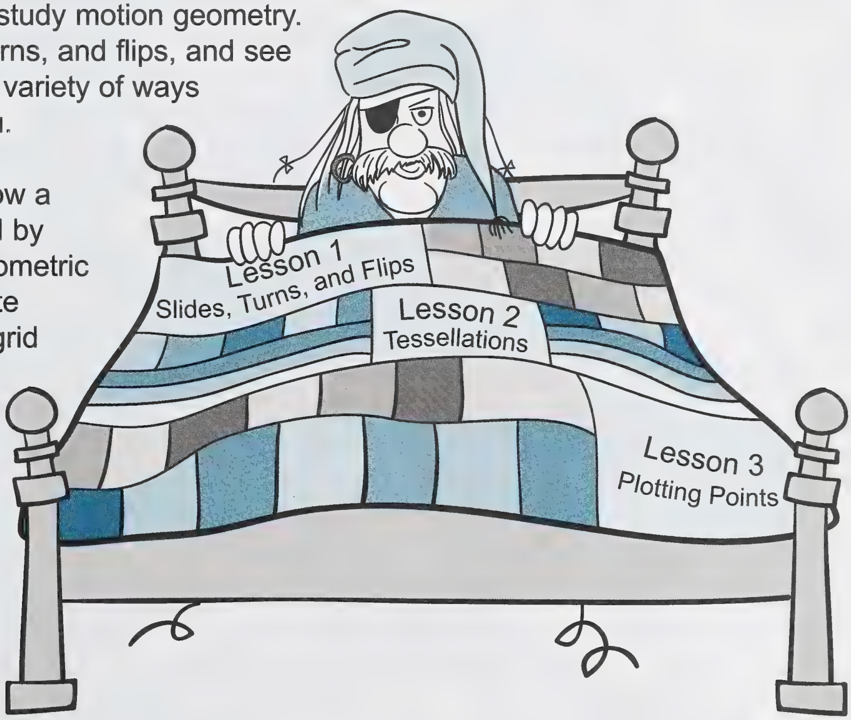
Module Overview

Have you ever slept under a thick down-filled quilt? When a cold Nor'wester was howling through his ship's rigging, Captain Quinn liked to snuggle under his quilt and dream of tropical islands.

In Canada during the nineteenth century, women used to sew elaborate geometric patterns into their quilts to make them attractive and comfortable. These patterns included squares, diamonds, rectangles, and triangles. If you look carefully at some of these quilts, you can see the same shape in several different spots. Sometimes you can see shapes turned through a variety of angles to form interesting designs. And sometimes you can see that shapes have been flipped over to create patterns that look as though they are reflections in a mirror. Some of the more popular designs are called unusual names, such as "Duck's Foot in the Mud" and "Toad in the Puddle."

In this module you will study motion geometry. You will study slides, turns, and flips, and see how they are used in a variety of ways in the world around you.

You will also explore how a surface can be covered by repeating the same geometric figure, and how to locate points on a surface or grid using number pairs.



Your mark on this module will be determined by how well you complete the two Assignment Booklets.

The mark distribution is as follows:

Assignment Booklet 4A

Lesson 1 Assignment	30 marks
Lesson 2 Assignment	30 marks

Assignment Booklet 4B

Lesson 3 Assignment	30 marks
Numbers in the News	10 marks
Total	100 marks

When doing the assignments, work slowly and carefully. Be sure you attempt each part of the assignments. If you are having difficulty, you may use your course materials to help you, but you must do the assignments by yourself.

You will submit Assignment Booklet 4A to your teacher before you begin Lesson 3. You will submit Assignment Booklet 4B to your teacher at the end of this module.

Numbers in the News 

Numbers are everywhere! Newpapers and magazines are full of stories and advertisements that show how numbers are used every day.

The following Scavenger Hunt asks you to look through newspapers and magazines for samples of number ideas like those you will be using in this module. Read through the list now and begin by collecting samples of the number ideas you already understand. You may collect other samples as you learn about them in the module.

Scavenger Hunt 

Cut out articles or advertisements from newspapers or magazines that show mathematics being used in different situations. Here are some suggestions of things to look for:

- pictures showing slides, turns, and flips that are found or used in everyday life
- pictures showing objects with line symmetry or point symmetry
- pictures showing tessellations that can be found in nature or everyday life
- graphs that use coordinates
- maps that show locations with points

You will find further instructions for submitting your project in Assignment Booklet 4B.

Lesson 1

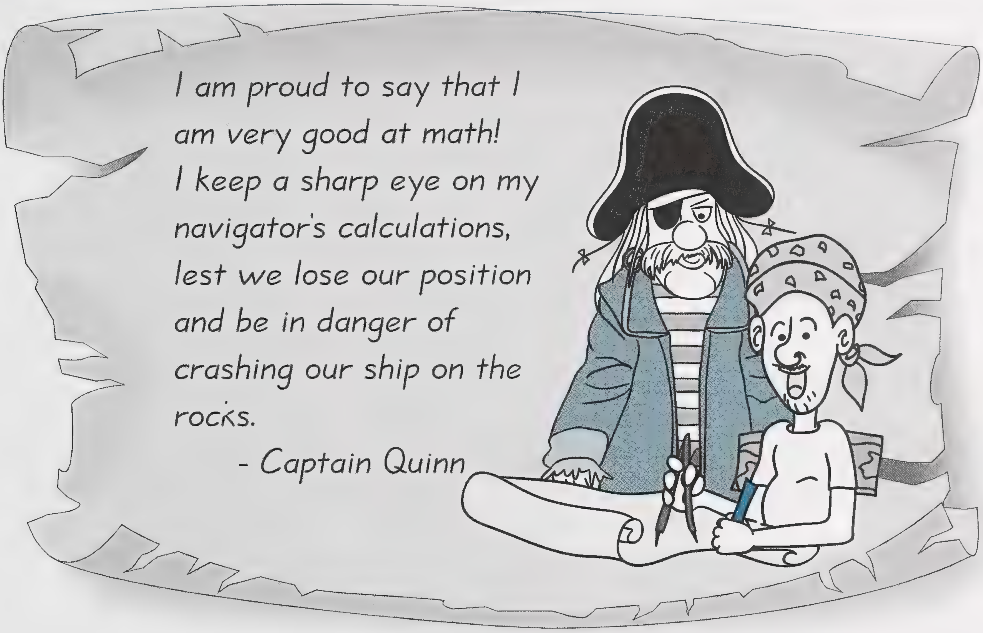
Slides, Turns, and Flips

Have you ever seen an iceberg? When the sea is calm, you can see both the top of the iceberg and its reflection in the water. But, beauty can be deceiving! Only $\frac{1}{10}$ of an iceberg is visible—the other $\frac{9}{10}$ lies unseen below the surface of the water, and is a danger to ships sailing nearby.

The reflection in the photograph is an example of one of the transformations in motion geometry that you will explore in this lesson. Reflections are often called *flips*. You will study slides, flips, and turns, and how these transformations can be used to describe relationships among geometric figures. You will also examine how these transformations are used in everyday life.

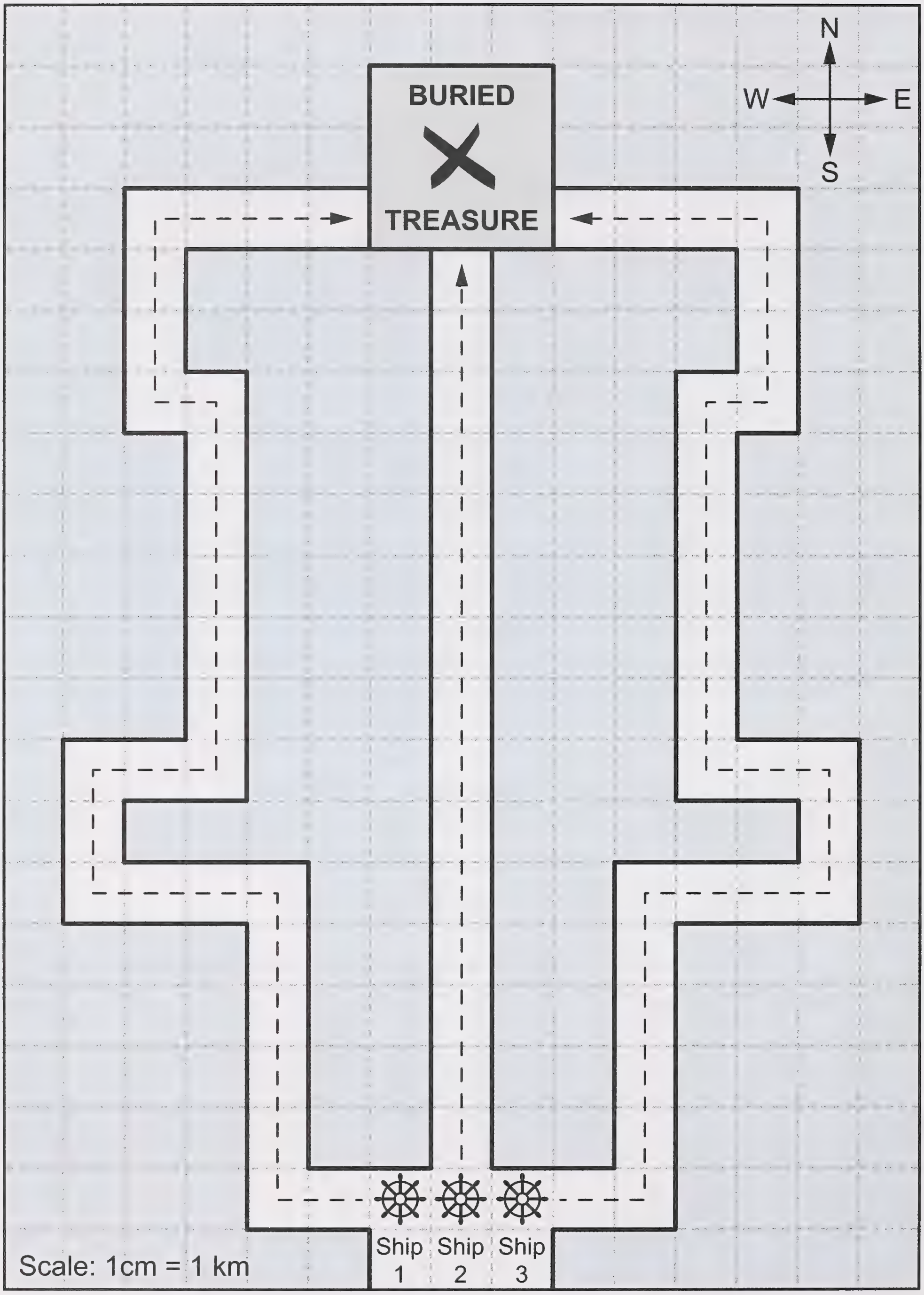
Activity 1

Today you will explore the meaning of slides, turns, and flips.



For centuries, navigation at sea has involved mathematics. A ship's crew must be able to calculate the position of their ship, the direction it is headed, the distance it should travel along this course, and when to change direction.

The picture on page 16 shows three ships that are heading towards an island with buried treasure. Imagine that you are standing at the wheel of one of the ships and are responsible for guiding the ship to the treasure island.



BURIED
TREASURE
N
W
E
S
Ship 1
Ship 2
Ship 3
Scale: 1cm = 1 km

1. a. Describe the course that each ship follows. In your description, include directions and distances.

   b. Which ship's course was easiest to describe? Explain.

   c. Compare your descriptions of the courses for Ship 1 and Ship 3. What do you notice? Explain.

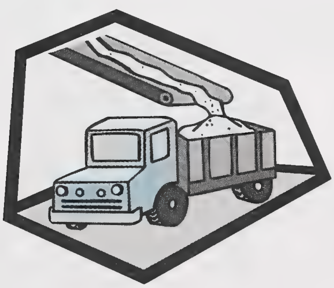
   d. If all three ships sail at the same speed, give the order in which the ships will arrive at the island. Explain.

Check your answers on page 75 in the Appendix.

Look at the path of Ship 2 on page 16. It is a **slide**.

A slide is a motion in which an object moves from a starting position to a finishing position in a straight line. The new position of the object after the slide is the **slide image**.

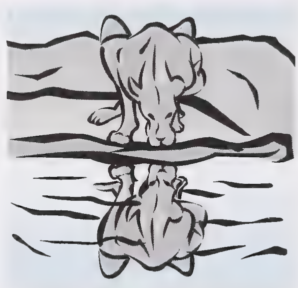
An example of a slide in everyday life is an object moving on a straight conveyor belt.



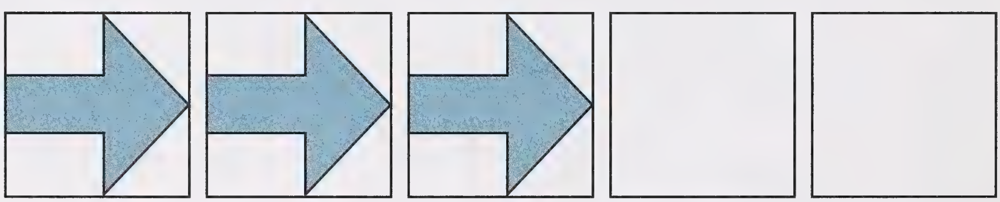
Look at the paths of Ships 1 and 3 on page 16. If you fold the grid along Ship 2's path, Ship 3's path falls on Ship 1's path. This means that Ship 1's path is the **flip image** of Ship 3's path. Ship 2's path is the **flip line**.

A **flip** is a motion in which an object is flipped or reflected over a fixed line, called the flip line. The flip image is the mirror image of the original position.

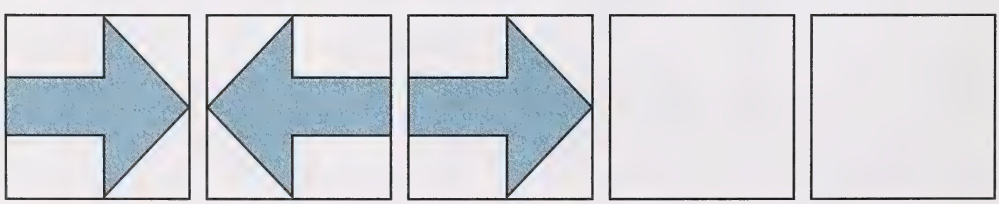
An example of a flip in everyday life is a reflection in water or a pancake being flipped.



2. a. The following diagram shows a shape that has been moved in a slide motion. What will the shapes in the next two boxes look like?



b. The following diagram shows a shape that has been moved in a flip motion. What will the shapes in the next two boxes look like?

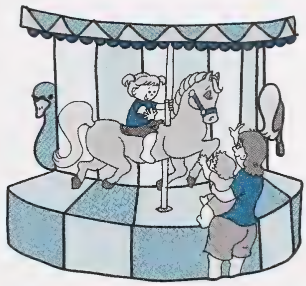


Check your answers on page 75 in the Appendix.

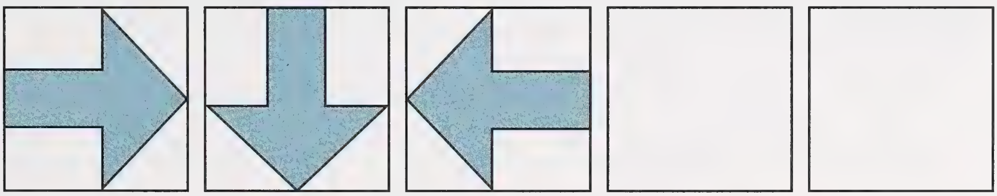
Look at the ships on page 16 again. The paths that Ship 1 and Ship 3 took included several **turns**.

A **turn** is a motion in which an object is turned about a fixed point, called the **turn centre**. The new position of the object after the turn is called the **turn image**.

An example of a turn in everyday life is a ferris wheel or a carousel.



3. The following diagram shows a shape that has been moved in a turn motion three times. What will the shapes in the next two boxes look like?



Check your answer on page 76 in the Appendix.

The direction of a turn can be described as **clockwise** or **counterclockwise**. Remember, the hands of a clock move in a clockwise direction. The opposite direction is called counterclockwise.

The angle of a turn can be expressed in degrees or as a fraction of a turn. Remember, a full turn is 360°, a $\frac{1}{4}$ turn is 90°, a $\frac{1}{2}$ turn is 180°, and a $\frac{3}{4}$ turn is 270°.

4. Write $\frac{1}{4}$ **turn**, $\frac{1}{2}$ **turn**, $\frac{3}{4}$ **turn**, or **full turn** to describe the **clockwise** turn of each of the following letters. Each letter began in the upright position.

a. 

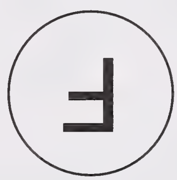
b. 

c. 

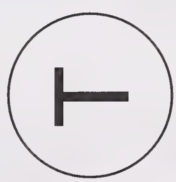
d. 

5. Write $\frac{1}{4}$ **turn**, $\frac{1}{2}$ **turn**, $\frac{3}{4}$ **turn**, or **full turn** to describe the **counter-clockwise** turn of each of the following letters. Each letter began in the upright position.

a. 

b. 

c. 

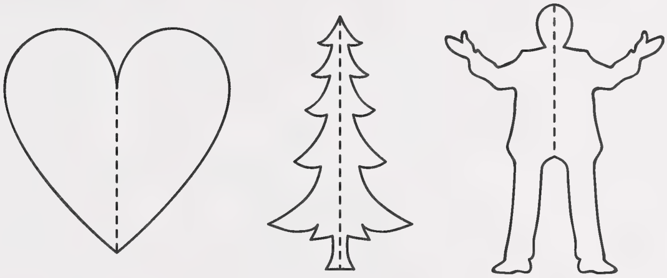
d. 

Check your answers on page 76 in the Appendix.

Activity 2

Today you will discover how symmetry is related to flips and turns.

Have you ever made designs like these by folding and cutting paper?



Each of these designs has **line symmetry**.

Line symmetry is the property in which one-half of the shape can be flipped onto the other half so the two halves match exactly. The line that divides the shape into two matching parts is called the **line of symmetry**.

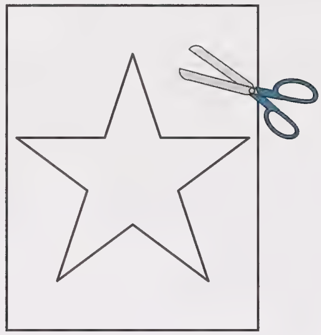
You can test for line symmetry using tracing paper.

Example

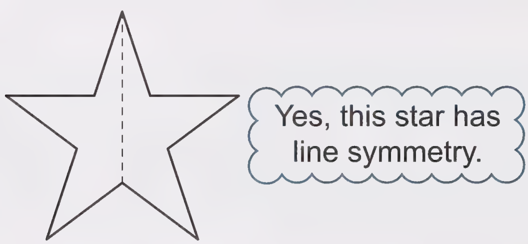
Does this star have line symmetry?

To test for line symmetry, do the following steps:

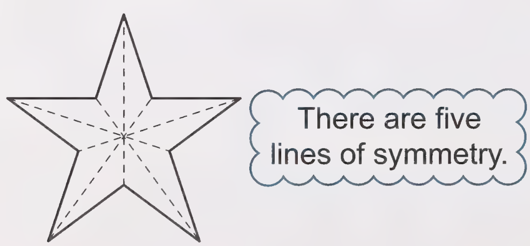
Step 1: Trace the figure and cut out the tracing.



Step 2: If the star has line symmetry, you can fold the cutting so that the left side matches the right side (a flip).



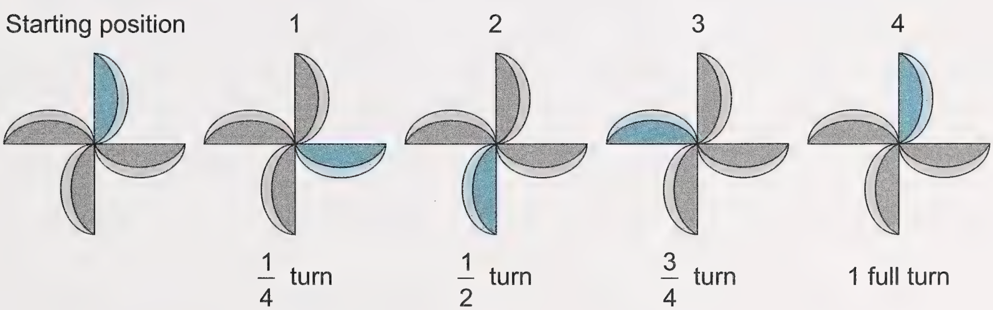
Note: Test to see how many different lines of symmetry there are. In other words, check how many ways the cutting can be folded so the left side matches the right side.



1. Find the page of shapes in the Appendix. Use tracing paper to test each shape for line symmetry. Which shapes have line symmetry? Make a sketch of each shape and show all lines of symmetry.

Check your answers on page 76 in the Appendix.

Have you ever played with a pinwheel? A pinwheel does not have line symmetry, but it can be turned around its centre in such a way that it is in the same position more than once in a full turn.



The pinwheel has **point symmetry**.

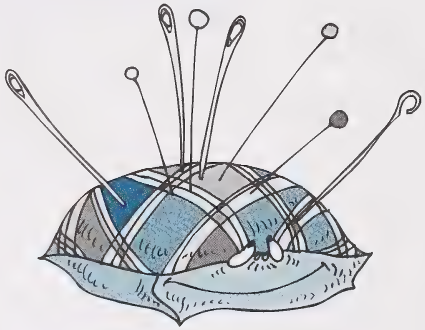
Point symmetry is the property in which a shape matches with its original position more than once in a full turn.

The turn centre about which a figure can be turned is called the **point of symmetry**.

You can use thin paper and pins to test for point symmetry.

Example

Does this star have point symmetry?

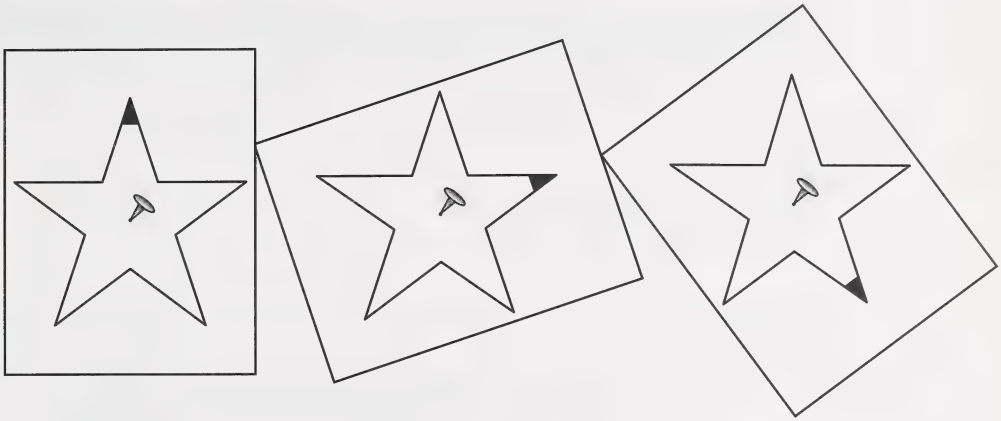


To test for point symmetry, do the following steps:

Step 1: Cover the figure with the thin paper (airmail paper or tracing paper), put a pin through the turn centre, and trace the figure. To keep track of the positions as the star turns, mark one point on the tracing of the star.

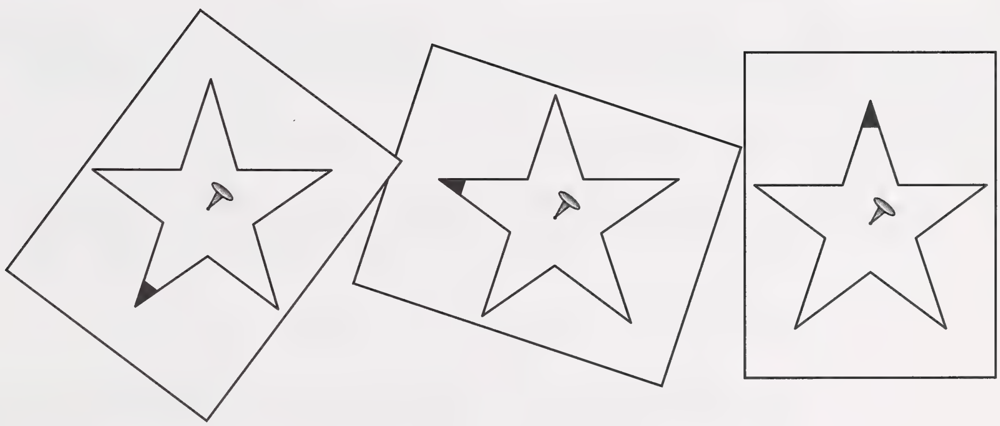
Step 2: Test to see if the star has point symmetry. Does the figure match the original more than once in a full turn?

Starting postion | 1 | 2



$\frac{1}{5}$ turn | $\frac{2}{5}$ turn

3 | 4 | 5



$\frac{3}{5}$ turn | $\frac{4}{5}$ turn | 1 full turn

Yes, the star has point symmetry. In one full turn, the star matches the original position five times.

2. Find the page of shapes in the Appendix. Use tracing paper and a pin to test each shape for point symmetry. Which shapes have point symmetry?

Check your answers on pages 77 and 78 in the Appendix.

Activity 3

Today you will explore line symmetry and point symmetry.

WHAT DO YOU SEE IN THE MIRROR?

?RORRIM EHT NI EES UOY OD TAHW

Hold this page up to a large wall mirror. Compare the message and its reflection.

1. Look at each word of the message and the reflection.

   a. In which direction is each word spelled in the message?
   b. In which direction is each word spelled in its reflection?

2. Look at each letter of the message and the reflection.

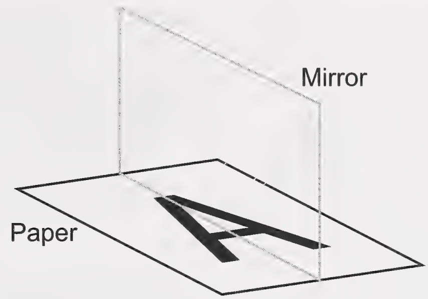
   a. Which letters look the same as their reflections?
   b. Which letters have reflections that appear to be formed backward?

Check your answers on page 78 in the Appendix.

The letters of the alphabet that look the same in the reflected message have a vertical line of symmetry. The vertical line of symmetry cuts the letter in half. When you place a mirror on this line, you can see the whole letter by looking at either the right half or the left half of the letter, along with its reflection.

Example

The letter A has a vertical line of symmetry.



3. Find the pull-out sheet of letters and numerals in the Appendix. Use a small rectangular mirror to discover which letters have a vertical line of symmetry.

a. Name all the letters that have a vertical line of symmetry.

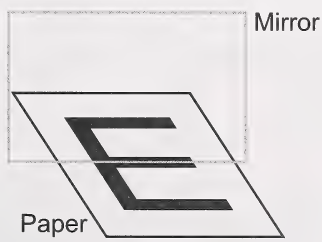
b. For each letter that has a vertical line of symmetry, draw a line to show where you placed the mirror.

Check your answers on page 78 in the Appendix.

Sometimes a letter has a horizontal line of symmetry that cuts the letter in half. When you place a small rectangular mirror on this line, you can see the whole letter by looking at either the top half or the bottom half of the letter, along with its reflection.

Example

The letter E has a horizontal line of symmetry.



4. Find the sheet of letters and numerals in the Appendix. Use a small rectangular mirror to discover which letters have a horizontal line of symmetry.

   a. Name all the letters that have a horizontal line of symmetry.

   b. For each letter that has a horizontal line of symmetry, draw a line to show where you placed the mirror.

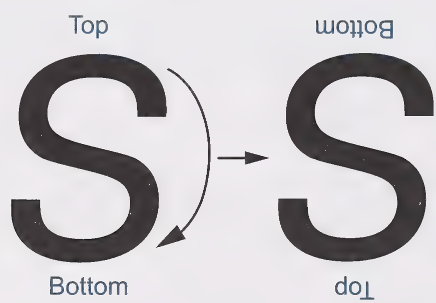
5. Name all the letters that have both vertical and horizontal lines of symmetry.

Check your answers on page 79 in the Appendix.

Some letters have point symmetry. These letters look the same upside down as they do right-side up.

Example

The letter S has point symmetry.



6. Find the sheet of letters and numerals in the Appendix. Use the sheet to discover which letters have point symmetry. Name all the letters that have point symmetry.

7. Name all the letters that have both line symmetry and point symmetry.

8. Name all the letters that have neither line symmetry nor point symmetry.

Check your answers on page 79 in the Appendix.

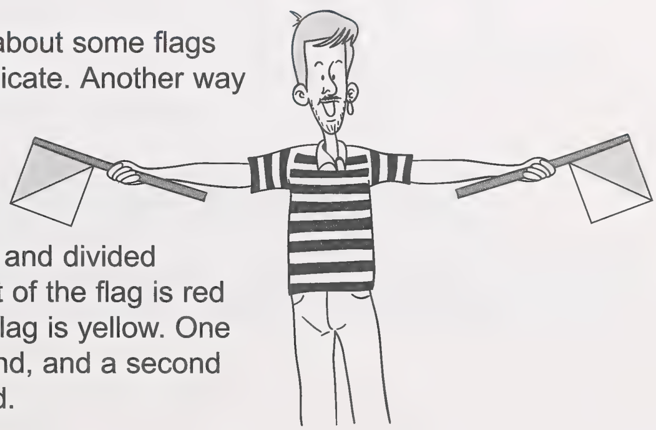
Sharing Time

Now it's time to show your home instructor what you have been learning.

Find the sheet of letters and numerals in the Appendix. Discuss with your home instructor which numerals on the sheet have line symmetry and which have point symmetry.

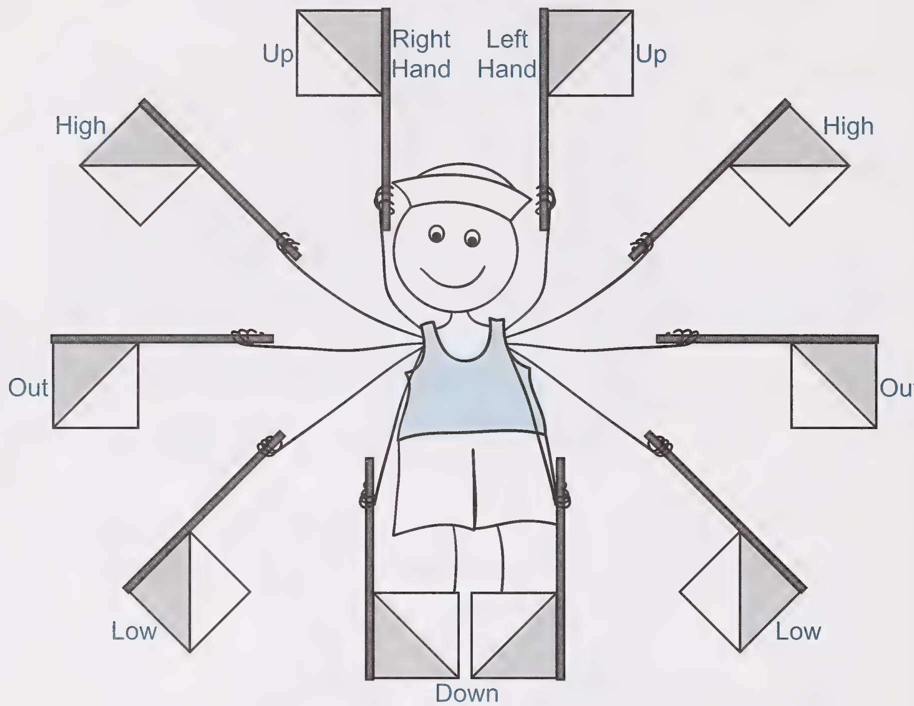
Activity 4

Today you will use your knowledge of turns to describe signals at sea.



In Module 3 you learned about some flags that ships use to communicate. Another way that flags are used to send messages at sea is using a special pattern called **semaphore**. The semaphore flag is square and divided diagonally. The upper part of the flag is red and the lower part of the flag is yellow. One flag is held in the right hand, and a second flag is held in the left hand.

For the semaphore alphabet, the signaller stands with arms extended so that the top of the arm at the shoulder is a turn centre. Each hand turns like a clock hand and stops at one of the following positions: up, high, out, low, or down.



Notice how the flag positions are related to each other. Answer the following questions as if you are facing the signaller.

1. a. Tell what kind of motion you see when the signaller moves any of the right-hand flag positions to a different right-hand flag position.

   b. Tell what kind of motion you see when the signaller moves any of the left-hand flag positions to a different left-hand flag position.

Check your answers on page 79 in the Appendix.

2. Tell what turn direction (clockwise or counterclockwise) and amount of turn $\left(\frac{1}{4}, \frac{1}{2}, \text{or } \frac{3}{4}\right)$ you see when the signaller makes the following changes with his or her right hand.

   a. from an up position to an out position
   b. from an out position to an up position
   c. from a down position to an up position
   d. from an up position to a down position
   e. from a high position to a low position
   f. from a low position to a high position
   g. from a down position to an out position
   h. from an out position to a down position

3. Tell what turn direction (clockwise or counterclockwise) and amount of turn $\left(\frac{1}{4}, \frac{1}{2}, \text{or } \frac{3}{4}\right)$ you see when the signaller makes the following changes with his or her left hand.

   a. from an up position to an out position
   b. from an out position to an up position
   c. from a down position to an up position
   d. from an up position to a down position
   e. from a high position to a low position
   f. from a low position to a high position
   g. from a down position to an out position
   h. from an out position to a down position

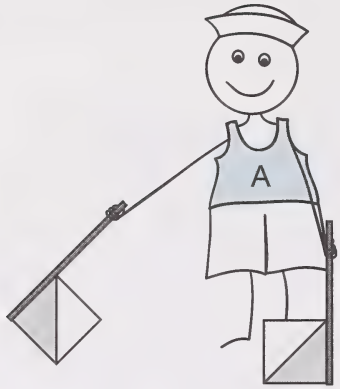
4. How does the answer to each part of question 2 compare to each part of question 3?

5. Tell what kind of motion relates the two flags in a signal if the signaller holds the flags in the following manner.

   a. the left-hand flag low and the right-hand flag high
   b. the left-hand flag high and the right-hand flag low

Check your answers on page 79 in the Appendix.

6. The following picture shows a sailor signalling the letter A.



a. Describe the hand positions for the letter A.

b. If you face the sailor and "mirror" his signal, you will signal the letter G. Describe how you would hold the flags to signal the letter G.

c. Draw a picture showing the flags for the letter G.

Check your answers on page 80 in the Appendix.

7. The following picture shows a sailor signalling the letter R.

a. Describe the hand positions for the letter R.

b. What kind of motion relates the two flags for the letter R?

c. The letter D is the only letter that can be signalled two ways. To signal the letter D, the signaller can do whichever of the following is more convenient:

- left hand down and right hand up
- left hand up and right hand down

Describe two different ways a signaller can move his or her hands to signal the letter D immediately after signalling the letter R.

8. The following picture shows a sailor signalling the letter U.

a. Describe the hand positions for the letter U.

b. What kind of motion relates the two flags for the letter U?

c. To signal the letter N immediately after signalling the letter U, a sailor can make a quarter turn clockwise with his left hand and a quarter turn counterclockwise with his right hand. Describe the signal for the letter N.

d. Draw a picture that shows the signal for the letter N.

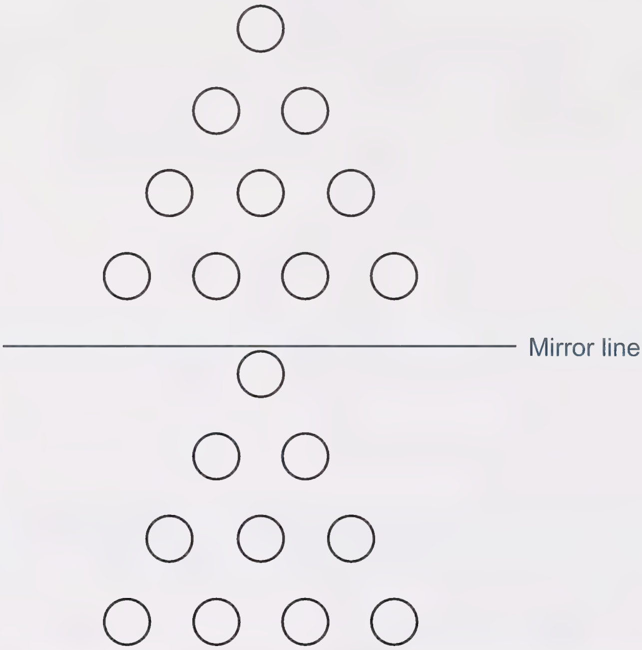
Check your answers on page 80 in the Appendix.

For additional information on semaphore, do some research on the Internet. You may find the following website helpful!

http://www.anbg.gov.au/flags/semaphore.html

Challenge Activity

Move only **three** of the bowling pins in the bottom picture so that they form the mirror image of the pins in the top picture.



Check your answers on page 81 in the Appendix.

Conclusion

In this lesson you were introduced to motion geometry by investigating slides, turns, and flips. You saw how these motions are used in the world around you.

Look for slides, turns, and flips in the designs of a variety of everyday objects such as the patterns on a bedspread, your clothing, wallpaper, or tiles in your kitchen.

NORTHWESTERN UNIVERSITY LIBRARY/EDWARD S. CURTIS

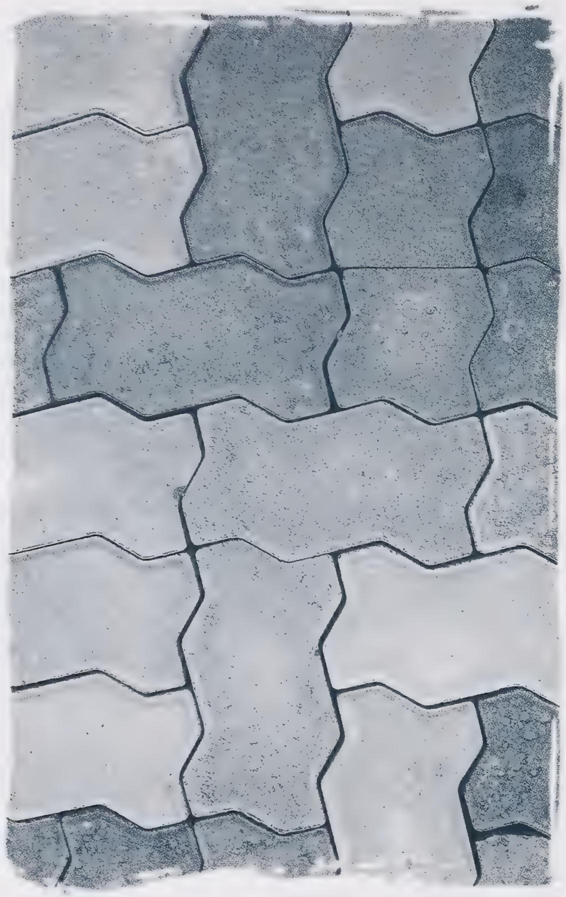
Can you find slides, turns, and flips in the clothing in the photograph?

Turn to Assignment Booklet 4A and complete the Lesson 1 Assignment.

Keep Assignment Booklet 4A until you have completed the entire booklet.

Lesson 2

Tessellations

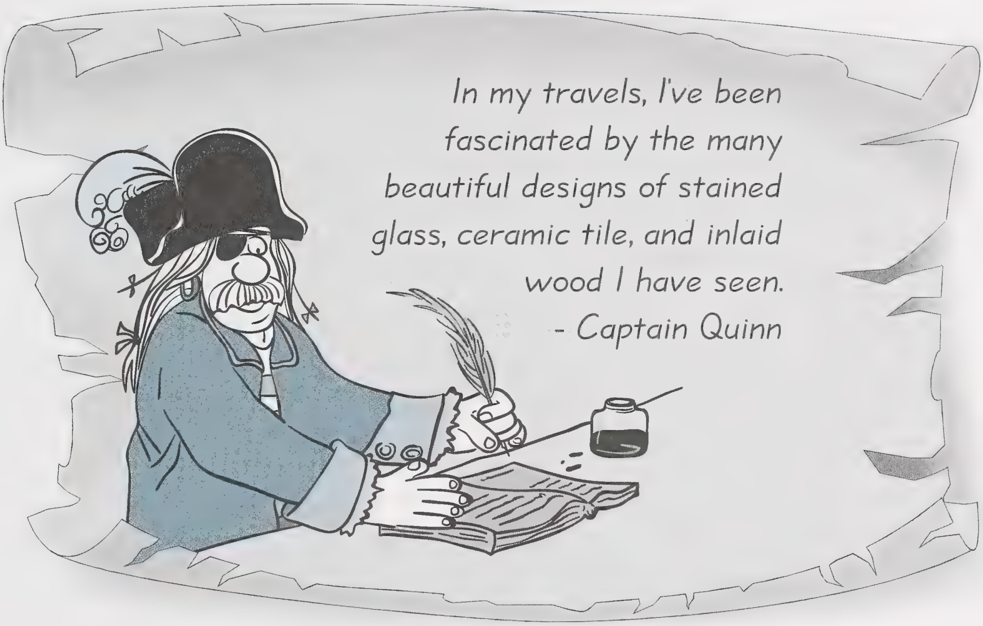


Have you ever watched workers laying a brick driveway or building a brick wall? The bricks are designed so that they fit closely together. When the driveway or wall is complete, the entire surface not only looks attractive but is strong and durable. Part of the beauty of brick structures is their repetitive geometric design.

In this lesson you will see how repeated geometric shapes are used to create practical and interesting surfaces. You will experiment to see what kind of shapes can be used, and how this process is related to slides, flips, and turns.

Activity 1

Today you will explore how to cover a surface with repeated geometric shapes.

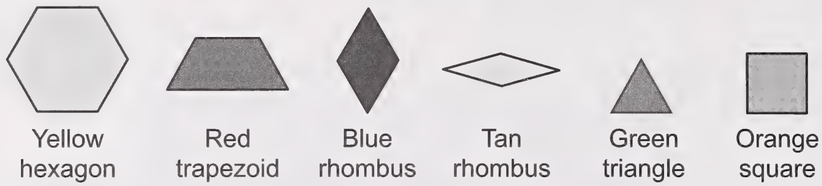


Turn to page 233 in your textbook. The photographs show designs similar to the ones Captain Quinn saw.

Notice how the shapes in each of the designs tessellate, or fit together, to cover the surfaces without gaps or overlaps.

A set of shapes that covers a whole surface without gaps or overlaps is called a **tessellation** or a tiling. The shapes may or may not all be identical.

Use a set of pattern blocks to answer questions 1 through 4.



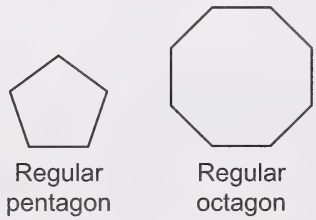
1. Mr. Singh wants to cover his rectangular kitchen counter using only one shape of ceramic tile. The pattern blocks shown above represent the different shapes of tiles he can buy.

   a. What do you notice about the lengths of the sides of the tiles (pattern blocks)?

   b. Sort your pattern blocks into sets of different shapes. Experiment with each type of pattern block and tell which shapes would tessellate as Mr. Singh wants. (**Note:** Only the tiles that stick out over the edges of the counter can be trimmed.)

2. Mr. Singh showed his wife the types of tiles that tessellate, and asked her to pick one. She said she wanted a tile that was a regular polygon. (A regular polygon has equal sides and equal angles.) Which of the pattern blocks are regular polygons?

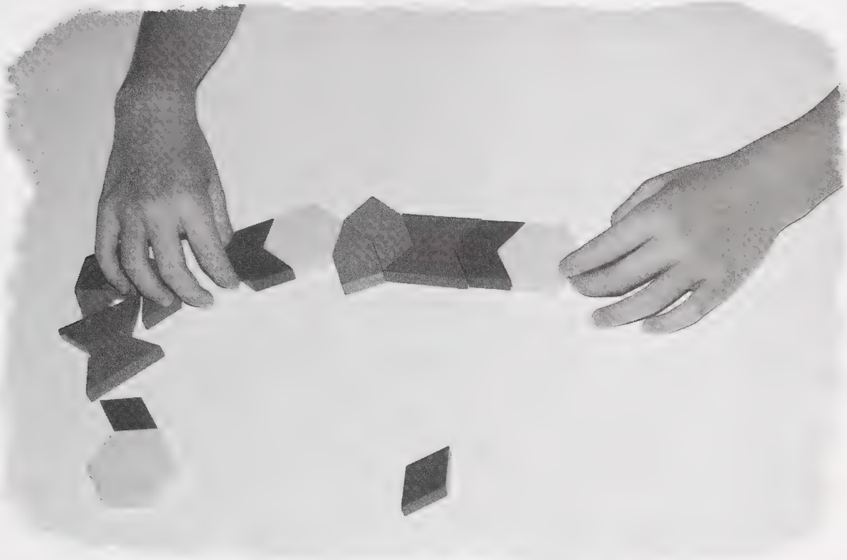
3. The manager of the tile store phoned the Singhs with the news that he had just received new tiles that were regular pentagons and regular octagons. The sides of these tiles are the same length as the other tiles.



   a. Turn to the Appendix and find the two shapes. Trace each shape on a sheet of paper to see if each shape will tessellate.

   b. If the new tiles don't tessellate, tell which of the original tiles the Singhs would need to fill the gaps that are formed between the new tiles.

4. A variety of shapes can be used to make patterns when tiling a surface. Use your pattern blocks to create a tessellation that is at least 25 cm by 25 cm in area.



Check your answers on pages 81 and 82 in the Appendix.

Sharing Time

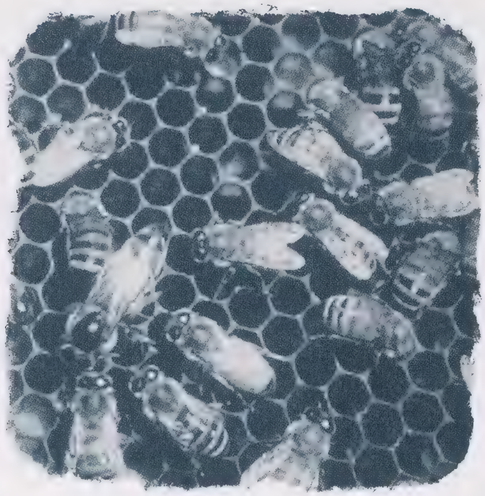
Now it's time to show your home instructor what you have been learning.

There are many examples of tessellations around your home and in your neighbourhood.

Together with your home instructor, complete the activity on page 101 of your Practice and Homework Book.

Activity 2

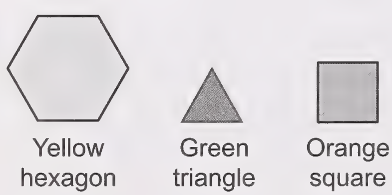
Today you will discover that people are not the only ones to use tessellations.



ALBERTA AGRICULTURE FOOD AND RURAL DEVELOPMENT

These bees must have had a geometry lesson! In order to store honey in their hives, they make hexagonal cells by building walls with wax. These honeycombs allow them to store the greatest amount of honey using the least amount of wax.

The only three regular polygons that can tessellate are equilateral triangles, squares, and regular hexagons, so use the following three shapes from your pattern blocks to investigate why the bees use hexagons.



1. Begin with one yellow hexagon to represent the first cell in a honeycomb. Find the number of walls needed for one cell.

2. Suppose the bees make triangular cells with walls that are the same length as the sides of the hexagon.

   a. Cover the yellow hexagon pattern block with green triangles. Draw a picture of your work.

   b. Find the number of walls the bees need to make to store the same amount of honey as they can in one hexagonal cell.

   c. Explain why the bees make hexagonal cells rather than triangular cells.

3. Suppose the bees make square cells with walls that are the same length as the sides of the hexagon.

   a. Place two orange squares on top of the yellow hexagon pattern block. Draw a picture of your work.

   b. Explain how the area covered by two squares compares to the area covered by one hexagon.

   c. Find the number of walls the bees need in order to make two square cells.

   d. Explain why the bees make hexagonal cells rather than square cells.

Check your answers on page 83 in the Appendix.

4. Some bees were making a honeycomb. They built one cell the first day. Each day, they added another ring of cells all around the honeycomb.

   a. Find the hexagonal grid paper in the Appendix. Show how the honeycomb grew in one week by colouring the cells on the hexagonal grid paper. (**Hint:** Start in the centre of the page. If you colour the hexagons in every ring a different colour, it will be easier to see the separate rings.)

   b. Copy and complete the following table.

	Day						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Total Number of Rings in Honeycomb at End of Day	1						
Number of Cells in Ring Built That Day	1						
Total Number of Cells in Honeycomb	1						

   c. How does the number of cells in the ring built each day increase?

   d. What is the total number of cells in the honeycomb at the end of one week?

5. Honeycombs are built so that the edges of the cells match. Shade hexagonal grid paper to show all the different ways that the following number of cells could be connected. (A flip or turn of an arrangement is not considered to be a different arrangement.)

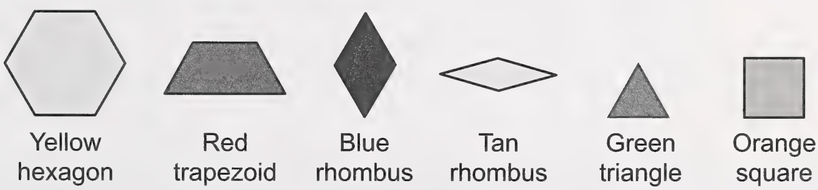
   a. two cells   b. three cells   c. four cells

Check your answers on pages 83 and 84 in the Appendix.

Activity 3

Today you will investigate tessellations using pattern blocks.

Use a set of pattern blocks to answer the following questions.



1. Four green triangles can be put together to make a larger triangle.

For each of the other five pattern blocks, try to use only blocks of that shape to make a larger polygon that has the same shape. You may slide, flip, or turn the blocks. Draw pictures that show whether it is possible to make the shapes.

2. Use pattern blocks to see if it is possible to tessellate a surface using only the following blocks and motions. If it is not possible, show what other motions are needed. Draw pictures to show your work.

   a. the blue rhombus and slides
   b. the red trapezoid and flips
   c. the tan rhombus and turns

3. Use tape to fasten two different pattern blocks together.

   a. Draw a picture that shows the pattern blocks you used to make your new shape.

   b. Try to tessellate a surface with your new shape. Draw a picture to show your work.

4. Use the yellow hexagons, red trapezoids, blue rhombuses, and green triangles from your set of pattern blocks. Make an equilateral triangle (a triangle with equal sides) with each of the following combinations of pattern blocks. Draw pictures that show the pattern blocks you used.

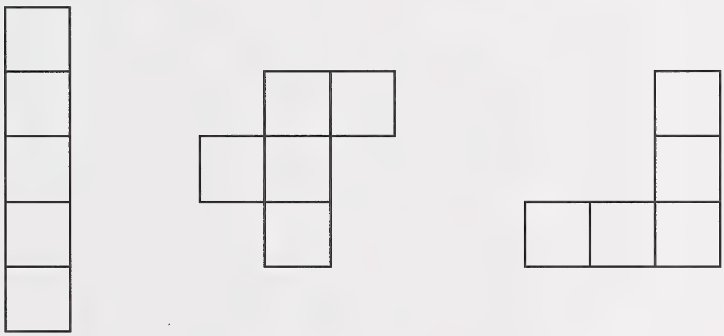
   a. two blocks that are different shapes
   b. three blocks, using two different shapes
   c. four blocks, using two different shapes
   d. five blocks, using three different shapes
   e. six blocks, using two different shapes
   f. seven blocks, using four different shapes

5. Use an equal number of orange squares and tan rhombuses (at least six of each). Make a tessellation with them so that the shared edges are different colours.

Check your answers on pages 84 to 86 in the Appendix.

Challenge Activity

Pentominoes are formed by joining five squares along their edges. Three pentominoes are shown below.



Twelve different pentominoes are possible. (Flips or turns of a shape are not considered to be different.)

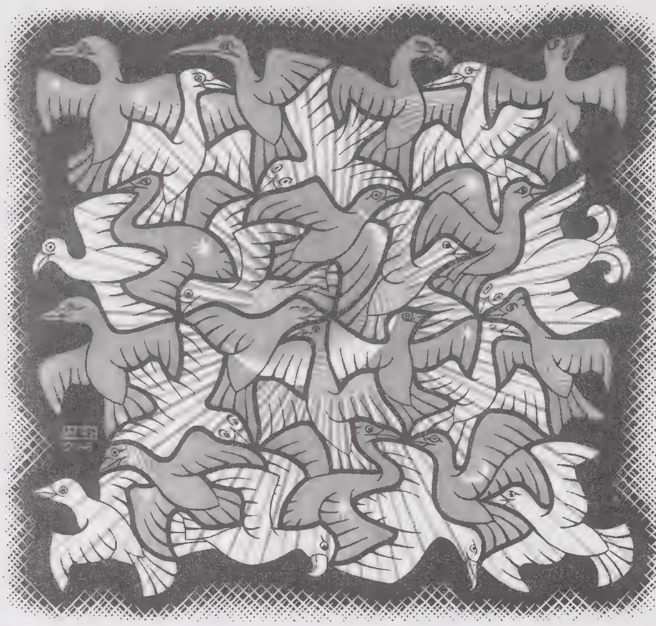
1. Find all 12 possible pentominoes by shading them on grid paper. Grid paper is provided in the Appendix.

2. Cut out your set of 12 pentominoes and fit them together so that they form a rectangle.

Check your answers on page 87 in the Appendix.

Conclusion

In this lesson you saw how tessellations are used to create designs in nature and everyday life for both practical and decorative purposes. You experimented with shapes to find which ones will tessellate. You solved problems by using slides, flips, and turns to cover surfaces with shapes.


[1]

M. C. Escher was a Dutch artist who incorporated repeating geometric patterns or tesselations in his work. Many admirers of his work consider him to be a mathematician as well as an artist. What do you think?

Turn to Assignment Booklet 4A and complete
the Lesson 2 Assignment.

When you are done, send Assignment Booklet 4A to your distance learning teacher to be marked.

Lesson 3

Plotting Points

Have you ever tried to find a house or business in a community where the streets are named? It can be a difficult process.

Addresses are easier to locate when the streets and avenues are numbered and intersect at right angles in a grid system. For example, if a house is at the corner of 51 Street and 50 Avenue, you know exactly how to get there.

In this lesson you will learn how to plot ordered pairs on a grid and to identify ordered pairs represented by points on a grid. You will see how plotting points is useful for making graphs and maps and drawing figures.

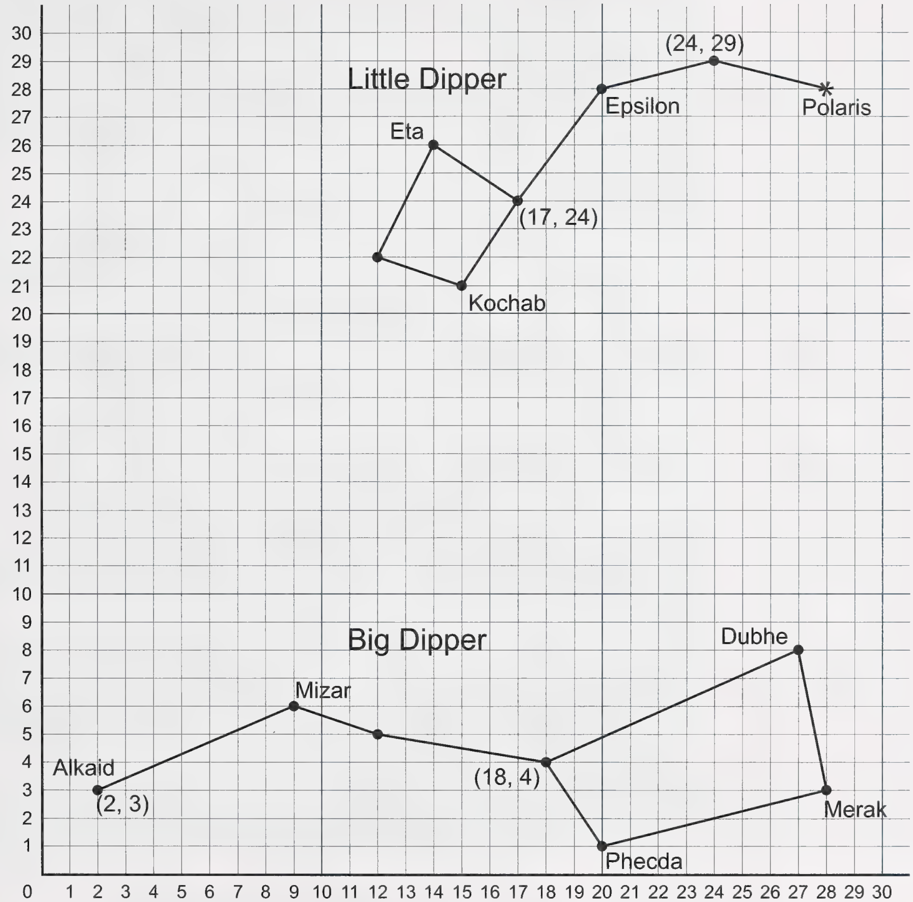
Activity 1

Today you will explore how to use grid systems and ordered pairs to locate points.

Since ancient times, the constellations in the night sky have been used as navigation guides. Ursa Major, or Great Bear, is the third largest constellation. Seven of the stars in Great Bear form the Big Dipper, which is one of the most easily recognized star formations. Because it never sets below the horizon, the Big Dipper is visible in northern skies year-round. Sailors on watch could tell the time at night by the position of the Big Dipper, which rotates around the North Star (Polaris) every 24 hours. The North Star is in the Little Dipper, which is part of Ursa Minor, or Lesser Bear. Finding the Big Dipper provides a starting point for locating the North Star.

The stars that form the Big Dipper and the Little Dipper can be represented by points on a **grid** called a **coordinate plane**. The position of any point is named by an **ordered pair** of numbers, called **coordinates**. The coordinates tell how far and in what direction a particular point is from the starting point of the coordinate plane, called the **origin**. The ordered pair describing the origin is $(0, 0)$.

The following picture shows the location of the origin at the very bottom left corner of the grid, as well as the names and ordered pairs for many of the stars.



Look for a pattern that relates the numbers in an ordered pair to the location of that point on the grid.

1. Look for the star Alkaid in the Big Dipper. Its ordered pair is $(2, 3)$. What do the numbers in its ordered pair tell you?

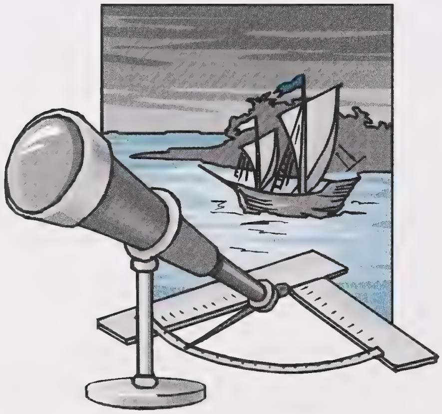
2. Put your finger on the star Mizar.

   a. What is the first number of its ordered pair? Explain.
   b. What is the second number of its ordered pair? Explain.

3. Copy and complete a table like the following.

Name of Star	Ordered Pair	Description (Slide from Origin)
Alioth		12 right and 5 up
Alkaid	(2, 3)	2 right and 3 up
Dubhe		
Epsilon		
		14 right and 26 up
	(15, 21)	
Megrez		18 right and 4 up
Merak		
Mizar		
	(20, 1)	
Pherkad		12 right and 22 up
Polaris		
Yildum		24 right and 29 up
Zeta		17 right and 24 up

Check your answers on pages 87 and 88 in the Appendix.



4. The end of the tail of Draco, the Dragon constellation, passes between the Big Dipper and the Little Dipper. It includes stars that have the ordered pairs $(3, 17)$, $(21, 12)$, $(23, 12)$, and $(25, 11)$. Plot, label, and connect these stars on the grid on page 49.

5. One starry night, a sailor on night watch imagined taking a trip from Alkaid, at one end of the Big Dipper, to Dubhe, at the other end. This is his imaginary route:

   - I'll begin at Alkaid, slide 7 units right and slide 3 units up to Mizar.
   - Next, I'll slide 3 units right and slide 1 unit down to Alioth.
   - Then, I'll slide 6 units right and slide 1 unit down to Megrez.
   - Now, I'll slide 3 units down and slide 2 units right to Phecda.
   - Then, I'll slide 8 units right and slide 2 units up to Merak.
   - Finally, I'll slide 5 units up and slide 1 unit left, and end at Dubhe.

   Follow the directions the sailor described and use a dotted line to draw his path on the grid on page 49. Use ordered pairs to label the points where the sailor made turns in his imaginary journey.

6. In question 5, how many slides along the grid lines did the sailor need to make to move from one star to the next? Explain.

7. Moving along the grid lines from any star to any other star within the Big Dipper, do you always need to make two slides (one horizontal and one vertical)? Explain.

8. Moving along the grid lines from any star in the Big Dipper to any star in the Little Dipper, do you always need to make the same number of slides? Explain.

9. How can you tell the number of slides needed to move between any two stars just by looking at their coordinates? Explain.

Check your answers on pages 89 and 90 in the Appendix.

10. a. Which two stars in the Little Dipper appear to be closest to one another?

b. Moving only on the grid lines, what is the total distance of the two slides between the two stars in question 10.a.?

11. Does Epsilon appear to be closer to Eta or to Zeta? Explain by describing the total distances of the slides along the grid lines.

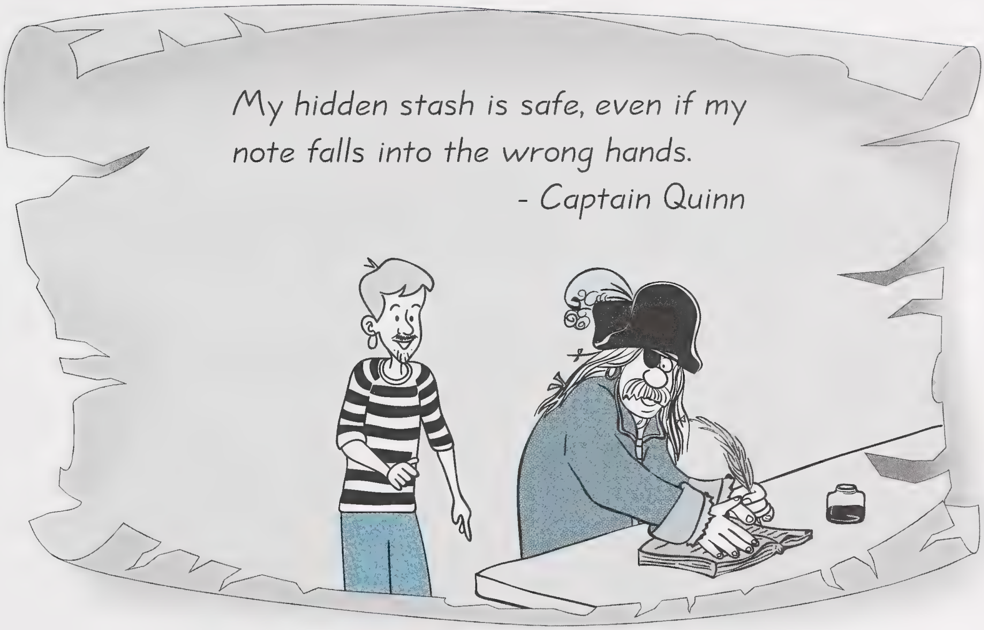
12. a. Which star appears to be closest to Zeta? Explain.

b. What would the coordinates of Pherkad have to be so that the quadrilateral formed using Eta, Zeta, Kochab, and Pherkad would be a square?

Check your answers on page 90 in the Appendix.

Activity 2

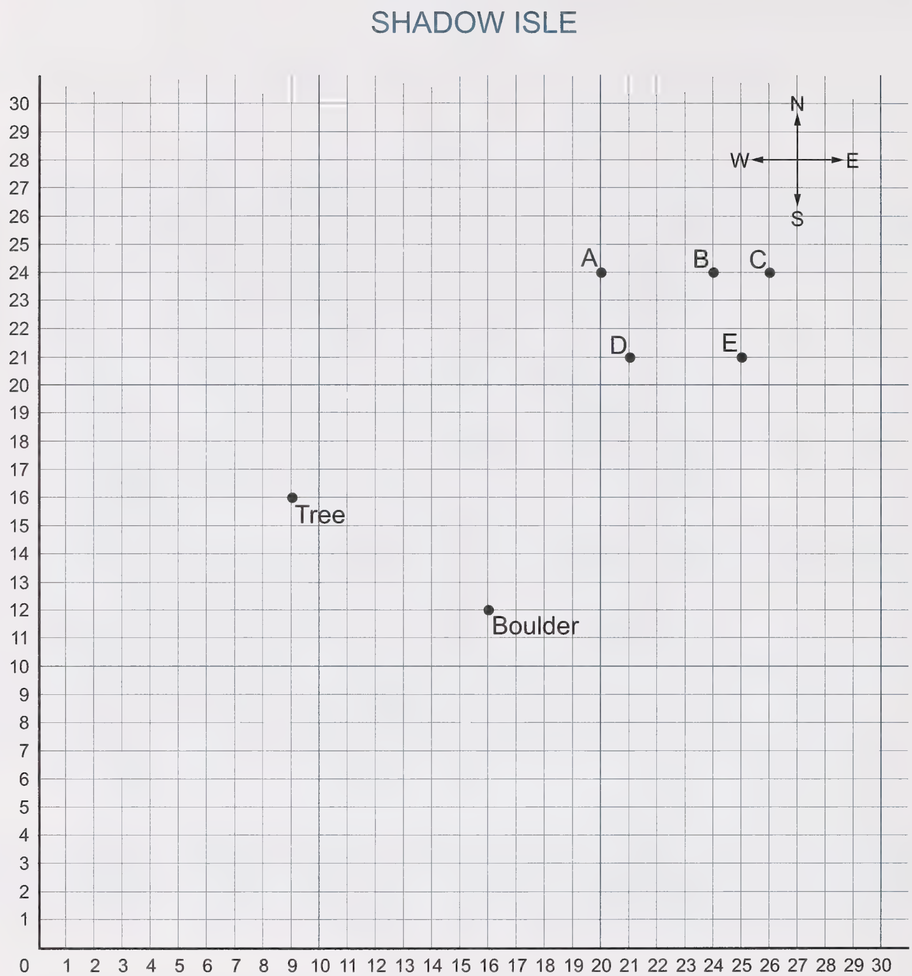
Today you will practise using ordered pairs to locate points in the coordinate plane.



Captain Quinn was wise enough to know the importance of getting emergency supplies quickly when he needed them on a voyage. He often visited Shadow Isle on his journeys, so it was a good place to stash things for later use.

Captain Quinn used his geometry skills to help him decide where to hide survival rations and other valuables. He made a map like a coordinate grid that he could use to locate hiding points on the island. He wrote clues to help himself remember where things were hidden. Even if his written clues fell into the wrong hands, he hoped that others would find it difficult to locate the hidden supplies.

Use the map of Shadow Isle to answer the following questions.



1. Here is one note that Captain Quinn wrote to himself.

Get the tree and boulder on Shadow Isle.

The Captain thought anyone who found the note would waste their time searching around the tree or the boulder on Shadow Island. Only he knew that the letters of the word **Get** told him that there was "**g**old" buried at the point on Shadow Isle that forms an almost perfect "**e**quilateral **t**riangle" with the tree and the boulder.

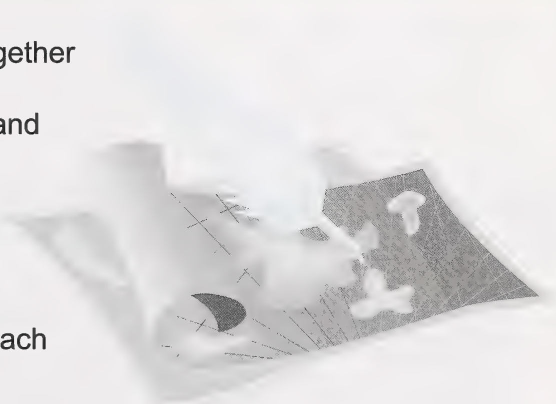
a. What are the coordinates of the tree and the boulder?

b. Estimate and then use your ruler to find the two possible points on the map where Captain Quinn may have buried his gold. Mark each possible point on the map, write **Gold here** beside it, and label it with its coordinates.

c. Suggest how Captain Quinn could make one small change to his clue so that there would be only one possible point where the gold could have been buried. Explain.

Check your answers on pages 91 and 92 in the Appendix.

2. The Captain buried different supplies at two points that, together with the tree and the boulder, formed a rectangle. The tree and the boulder were at diagonal corners of the rectangle. Find the two corners where the supplies were buried and mark both points on the map. Write **Supplies here** beside each point, and label it with its coordinates.



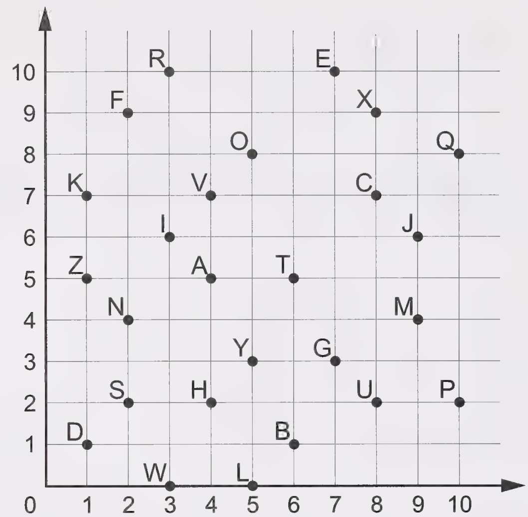
3. Some pirates had buried treasure at three points that, together with the boulder, formed a square. One of the points was six grid units down from the boulder. Find all the possible points where the treasure was buried, and mark these points on the map. Write **Pirate** beside each point, and label it with its coordinates.

4. A small but deep lake was found within the boundaries formed by the points $(3, 25)$, $(4, 27)$, $(6, 27)$, $(7, 25)$, and $(5, 24)$. Plot, label, and connect the points on the map in the order they are given.

5. Unusual rocks were found at points A, B, C, D, and E on the grid. List the ordered pairs for points A, B, C, D, and E.

6. Use the following ordered pairs to locate letters on the grid below. If you find the letters in order, you'll discover a secret message.

(6, 1), (8, 2), (3, 10), (3, 6), (7, 10), (1, 1), (6, 1), (5, 3), (6, 5), (4, 2), (7, 10), (5, 8), (4, 5), (1, 7), (6, 5), (3, 10), (7, 10), (7, 10)

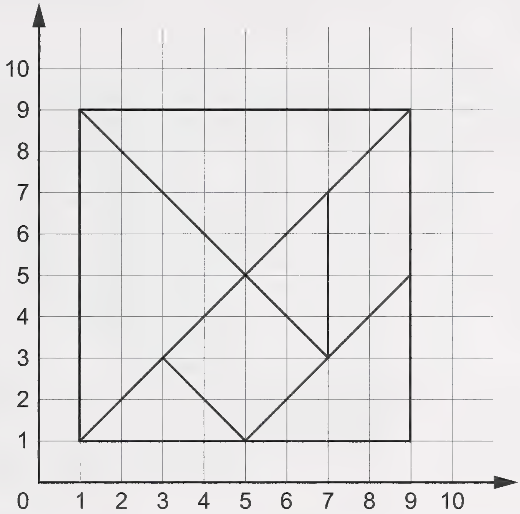


7. Draw a picture on a grid by plotting the ordered pairs and connecting them in the order they are listed. Use the 1-cm grid paper that is provided in the Appendix.

(5, 3), (1, 3), (3, 1), (7, 1), (10, 3), (5, 3), (5, 4), (1, 4), (5, 8), (5, 9), (10, 4), (5, 4), (5, 8)

Check your answers on page 92 in the Appendix.

8. An ancient puzzle called a tangram has been drawn on the grid below. Write directions, using ordered pairs, that someone else could follow to draw the tangram.



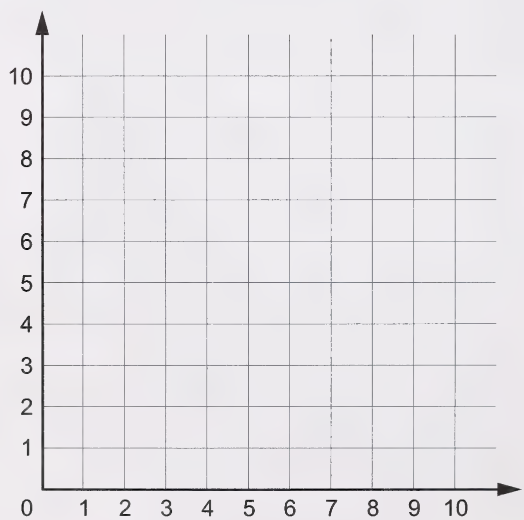
Check your answers on page 93 in the Appendix.

Activity 3

Today you will discover how to modify a grid in order to plot ordered pairs with large coordinates.

1. a. Tell which of the ordered pairs cannot be plotted on the grid that follows. Explain your answer.

(2, 1), (6, 8), (5, 5), (4, 12), (20, 8)



b. What is the greatest number that a point plotted on this grid could have as the first number in its ordered pair? Explain.

c. What is the greatest number that a point plotted on this grid could have as the second number in its ordered pair? Explain.

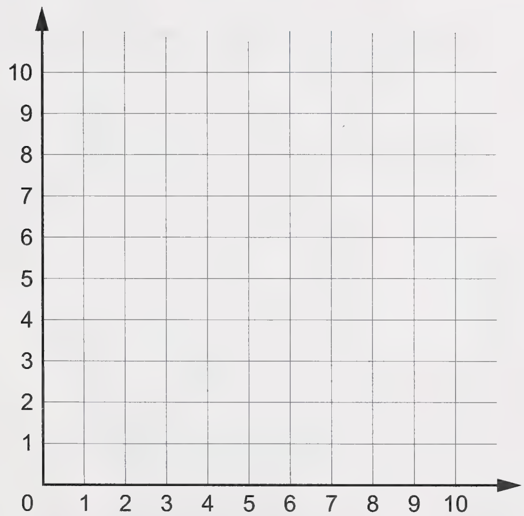
Check your answers on page 93 in the Appendix.

Some ordered pairs may contain numbers that are too large to plot on your grid paper. To solve this problem, you might try using a larger sheet of grid paper or one that has smaller squares. Even then, you might still have numbers that are too large to plot. Fortunately, there is a solution to this problem.

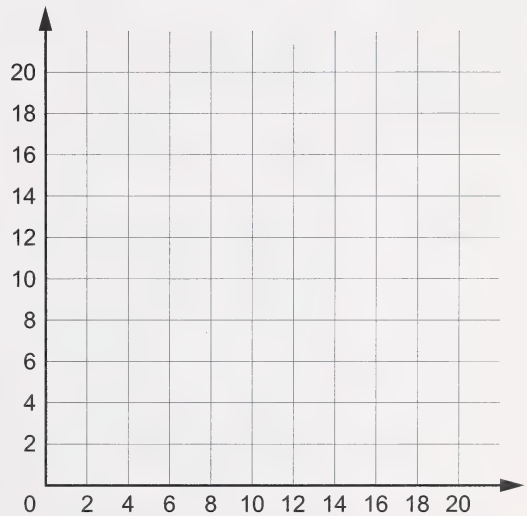
2. Look at Grid A and Grid B.

a. In what ways are they the same?
b. In what ways are they different?

Grid A



Grid B



3. a. For Grid A, write the ordered pair in which both the first number and the second number are the least possible. Describe the location of this point on the grid.

b. For Grid A, write the ordered pair in which both the first number and the second number are the greatest possible. Describe the location of this point on the grid.

4. a. For Grid B, write the ordered pair in which both the first number and the second number are the least possible. Describe the location of this point on the grid.

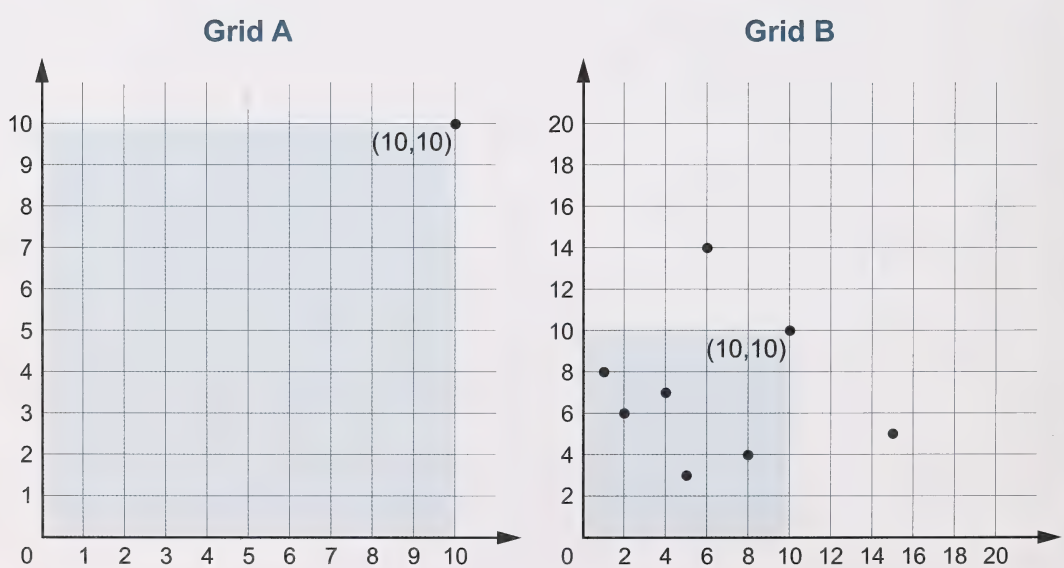
b. For Grid B, write the ordered pair in which both the first number and the second number are the greatest possible. Describe the location of this point on the grid.

Check your answers on pages 93 and 94 in the Appendix.

5. a. How do your answers for questions 3.a. and 4.a. compare?
b. How do your answers for questions 3.b. and 4.b. compare?

Check your answers on page 94 in the Appendix.

All the points that can be plotted on Grid A could be plotted in the shaded section on Grid B.



6. **a.** How do the number of shaded squares on Grid A compare with the number of shaded squares on Grid B?

   b. List the ordered pairs for each of the points shown on Grid B.

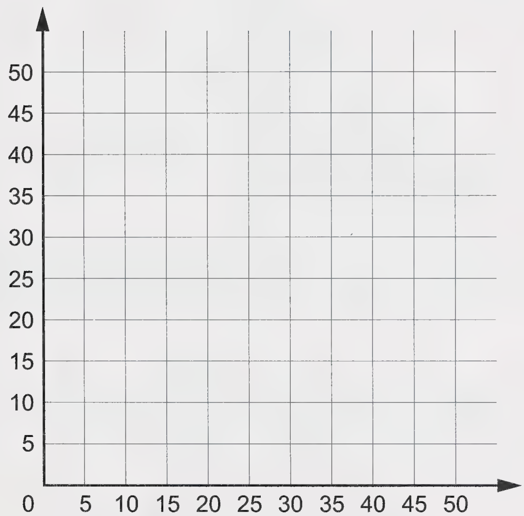
   c. The ordered pair (10, 10) is plotted on both grids. Use Grid A to plot as many of the other points as possible that are shown on Grid B.

   d. What is an advantage of using a scale that counts by 2s instead of by 1s?

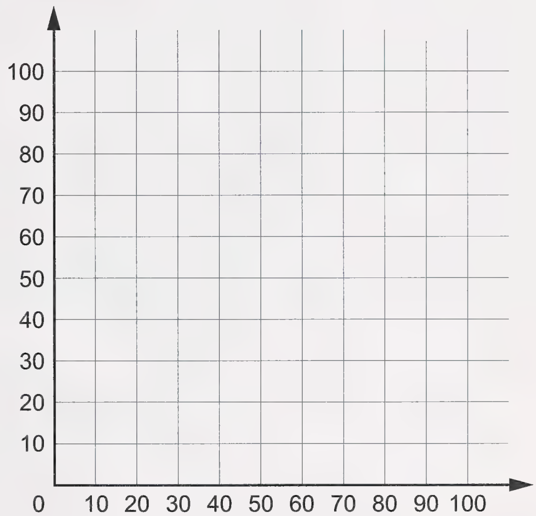
   e. What is a disadvantage of using a scale that counts by 2s instead of by 1s?

7. Look at Grid C and Grid D. Notice that Grid C uses a scale that counts by 5s and that Grid D uses a scale that counts by 10s.

Grid C



Grid D



   a. Highlight the squares on Grid C and on Grid D that show all the points that can be plotted on Grid A of question 6.

   b. What do you notice happening as the grid scales use larger multiples?

c. For Grid C, write the ordered pair in which both the first number and the second number are the greatest possible.

d. For Grid D, write the ordered pair in which both the first number and the second number are the greatest possible.

8. Suppose you were asked to plot the ordered pairs $(1, 5)$, $(12, 8)$, $(3, 10)$, $(2, 7)$, and $(5, 4)$. Notice that the largest number in the ordered pairs is 12. It cannot be plotted on Grid A, but it can be plotted on Grid B, Grid C, or Grid D. Why might it be best to use Grid B to plot this set of ordered pairs?

9. Which grid (A, B, C, or D) would be best to plot the following sets of ordered pairs?

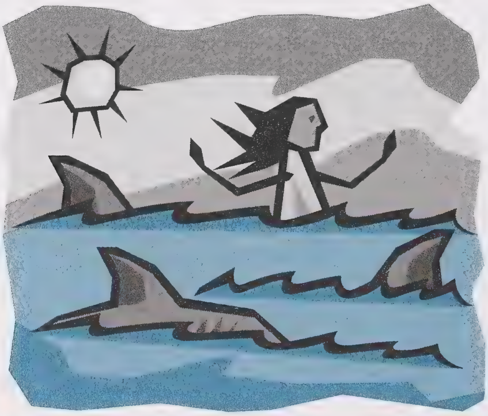
   a. $(2, 3)$, $(9, 8)$, $(4, 7)$, $(8, 9)$, and $(1, 5)$

   b. $(20, 60)$, $(3, 50)$, $(45, 2)$, $(75, 10)$, and $(30, 90)$

   c. $(16, 2)$, $(6, 24)$, $(9, 30)$, $(1, 5)$, and $(45, 25)$

10. For each set of ordered pairs in question 9, plot and label the points on a grid similar to the one you chose.

Check your answers on pages 94 to 97 in the Appendix.



Sharing Time

Now it's time to show your home instructor what you have been learning.

Explain to your home instructor how you plot a point on a grid.

Challenge Activity

1. Plot the following nine points on the grid. Use the 1-cm grid paper provided in the Appendix.

   $(4, 4)$, $(4, 6)$, $(4, 8)$, $(6, 4)$, $(6, 6)$, $(6, 8)$, $(8, 4)$, $(8, 6)$, $(8, 8)$

2. Connect all nine points using exactly four straight lines and without lifting your pencil from the paper.

Check your answers on page 97 in the Appendix.

Conclusion

In this lesson you learned how ordered pairs can be used to identify and plot points on a coordinate grid. You applied what you learned to solve problems when making and using maps and grids to identify locations.

In the late nineteenth century, before Alberta and Saskatchewan were provinces of Canada, surveyors mapped the Prairies using a grid system. The land was divided into squares called townships that are 6 miles (approximately 10 km) long on each side. The locations of these townships are given by two numbers, just as points in the coordinate plane are represented by ordered pairs.

Turn to Assignment Booklet 4B and complete the Lesson 3 Assignment.

Keep Assignment Booklet 4B until you have completed the entire booklet.

Module Summary

In Module 4 you were introduced to motion geometry. You learned to recognize slides, turns, and flips by seeing how they are used in the world around you. You explored tessellations and saw how these patterns are used to solve problems in nature and in everyday life. You learned how to plot points using coordinates. You used ordered pairs to identify points and learned to choose appropriate intervals on a graph.

Many of the principles of motion geometry can be found in designs in fabric, wallpaper, quilts, tiles, and architecture.

The photograph shows a design in a bedspread. Can you identify the slides, flips, and turns in the pattern?

Turn to Assignment Booklet 4B and complete the Numbers in the News project.

When you are done, send Assignment Booklet 4B to your distance learning teacher to be marked.

Keystrokes

Take out your calculator and complete the following exercises. They will help you review some of the ideas you have learned in Module 4.

Funky Feature: There's a Point to This!

1. **a.** Notice how the numbers on your calculator display are formed by short line segments. Use a pencil crayon to trace over the figures in the following table to show how the digits from 0 to 9 look on the display. For example, 0 is shown traced.

Keypad	0	1	2	3	4	5	6	7	8	9
Display										

b. In this module, you learned that figures have point symmetry if they look the same when you turn them upside down. Guess and check to find which of the calculator display digits have point symmetry.

c. Number **palindromes** are numbers that read the same forward and backward. Guess and check to find which of the following calculator displays for palindromes have point symmetry.

11, 373, 5445, 20 002, 69 896

d. Explain how you can predict whether or not the calculator display for a palindrome has point symmetry.

e. Using the calculator display and the digits 1, 2, and 8, find all the possible three-digit palindromes that have point symmetry.

f. Guess and check to find which of the calculator displays for the following palindromes have point symmetry.

2525, 102 021, 852 258, 1 224 221, 1 000 001

g. Write some sums using the digits 0, 1, 2, 5, and 8 so that the addends are palindromes and the calculator display of the answer has point symmetry. Two examples are shown.

$22 + 22 + 22 + 22 = 88$ and $101 + 101 = 202$

Check your answers on page 98 in the Appendix.

Funky Feature: Twin Digits

2. a. Display 6 on your calculator and turn the calculator slowly. Keep looking at the display. Does the digit 6 have turn symmetry?

   b. Keep 6 on the display and turn the calculator upside down. What number do you see?

   c. Display 9 on your calculator and turn the calculator slowly. Does 9 have turn symmetry?

   d. Keep 9 on the display and turn the calculator upside down. What number do you see?

   e. Use what you know about turn symmetry to explain how the display digits for 6 and 9 are related.

   f. Display the following numbers on your calculator one at a time. After you display each number, guess and check what number you will see when you turn the calculator upside down.

   69, 96, 66, 99, 626, 959, 689, 5695

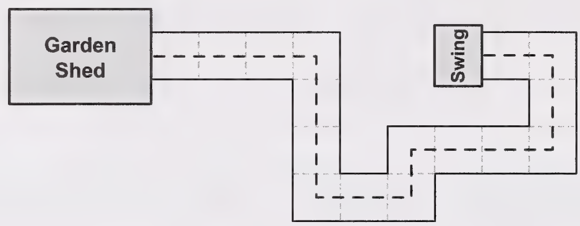
   g. Explain how you can use the digits 6 and 9 to display a multi-digit number that has point symmetry, even though it is not a palindrome. Give an example.

Check your answers on pages 98 and 99 in the Appendix.

Review

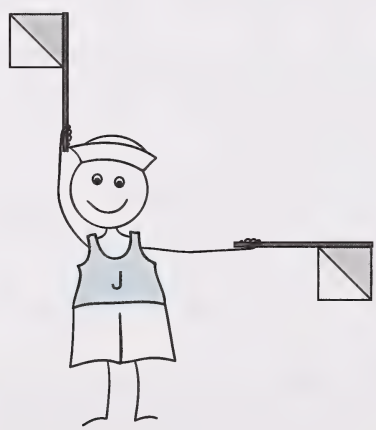
This review will help you apply what you learned in Module 4 and prepare for the final test. Discuss with your home instructor when you should begin the Review and how much of the Review you should complete.

1. The following diagram shows your walk along a garden path made with 1-m square sidewalk blocks.



Describe your walk along the path, beginning at the garden shed and ending at the swing. In your description, include directions and distances.

2. The following picture shows a sailor signalling the letter J.



a. Describe the signal for the letter J.

b. If you face the sailor and "mirror" his signal, you will signal the letter P. Describe how you would hold the flags to signal the letter P.

c. Draw a picture of the flags for the letter P.

3. Predict which letters in the word will look the same when held up to a mirror.

STARE

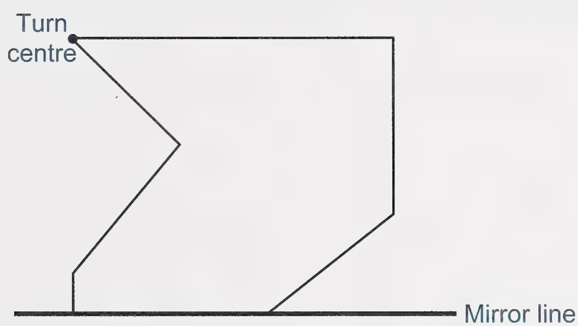
a. Hold the word in front of a mirror and copy what you see.

b. Which letters look the same? Draw them and show their lines of symmetry.

c. Which of the other letters have a different kind of symmetry? Explain.

If you need help with questions 1 to 3, look back at Lesson 1, where you learned about slides, flips, and turns. If you feel you need more practice, do question 4.

4. Trace this shape on paper and cut it out. Place the cutout in the centre of a page and trace it. Place the cutout on top of the tracing to begin each motion.



a. Slide the cutout 5 cm to the right and trace it.

b. Flip the cutout, using the mirror line shown, and trace it.

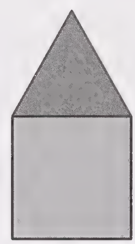
c. Turn the cutout a quarter turn clockwise, using the turn centre shown, and trace it.

Check your answers on pages 99 and 100 in the Appendix.

5. Turn to page 232 of your textbook. For each of the figures shown in Practise Your Skills, draw pictures to show whether it can be used to tessellate a surface.

If you need help with question 5, look back at Lesson 2, where you learned about tessellations. If you feel you need more practice, do question 6.

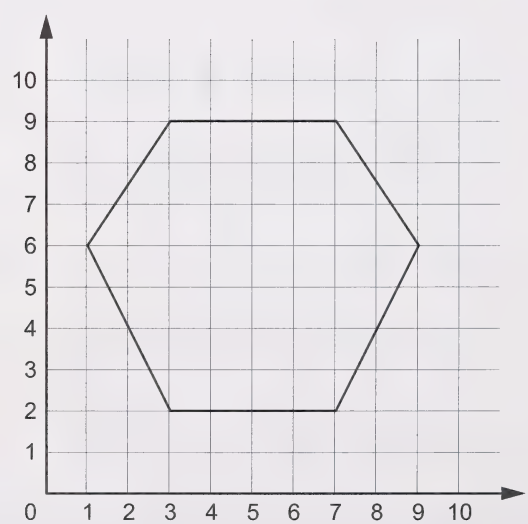
6. Put an orange square and a green triangle from a set of pattern blocks together to make this shape.



Draw a picture to show how you can use this shape to tessellate a surface. You may slide, flip, or turn the shape.

Check your answers on page 101 in the Appendix.

7. **a.** Use ordered pairs to label the corners of the hexagon shown.

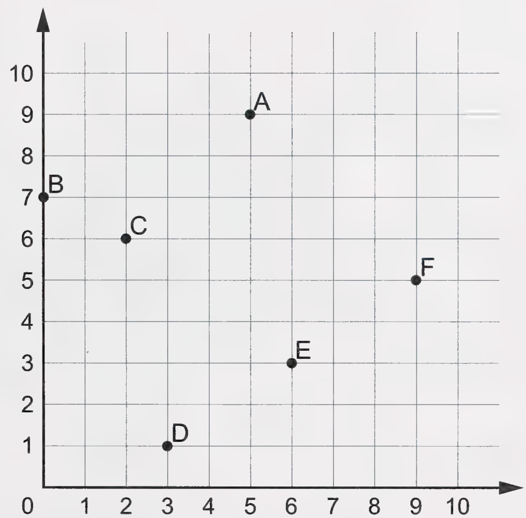


b. The diagonal corners of a square are at $(9, 7)$ and $(4, 2)$. Draw the square and use ordered pairs to label its corners.

c. Draw the largest possible rectangle inside the square. The rectangle must have no corners touching the square, but one of its corners must touch the hexagon. Use ordered pairs to label the corners of the rectangle.

If you need help with Question 7, look back at Lesson 3, where you learned about plotting and identifying points. If you feel you need more practice, do question 8.

8. a. List the ordered pairs for points A, B, C, D, E, and F.

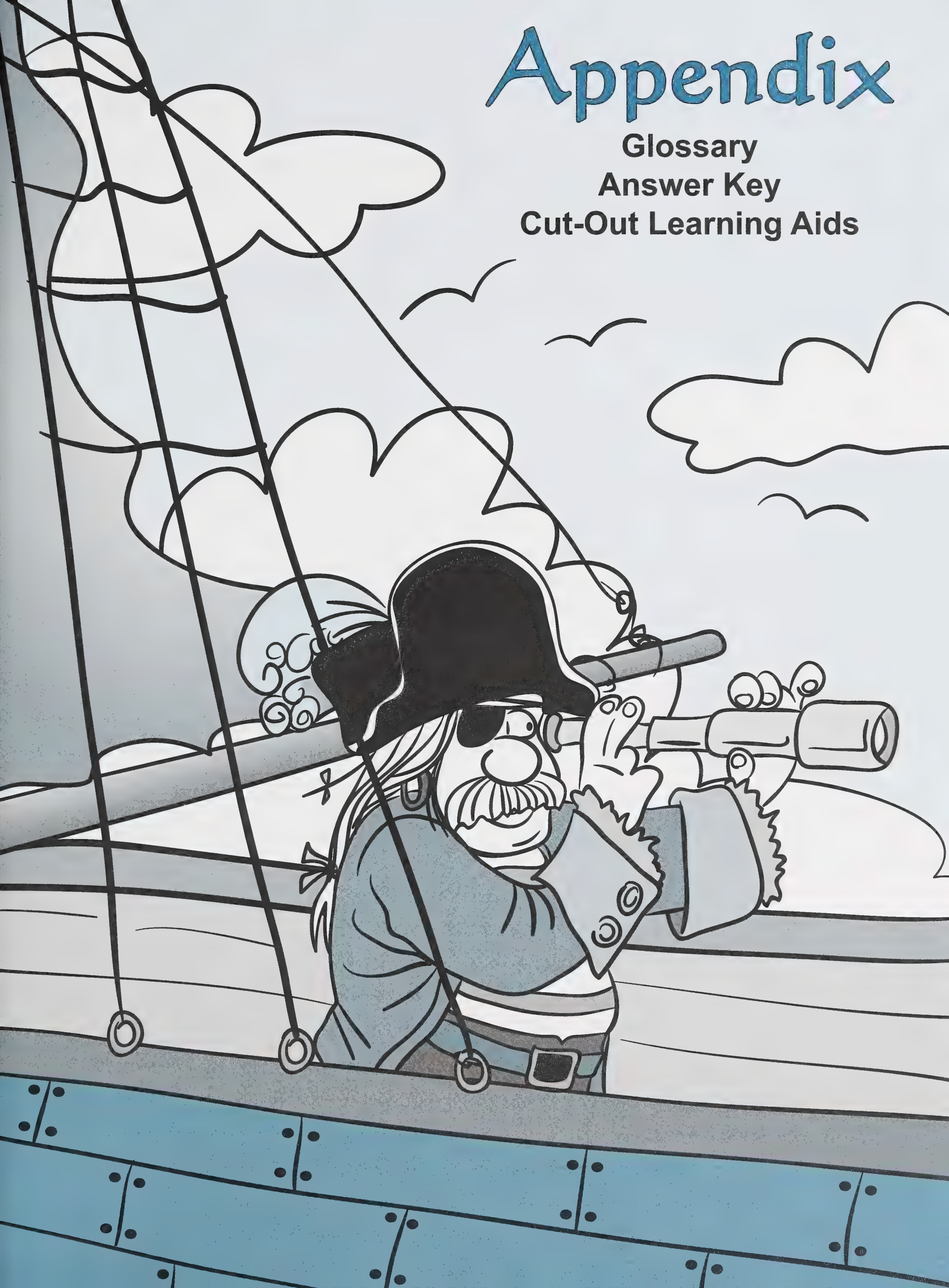


b. Plot and label the following points on the grid: $(1, 4)$, $(2, 8)$, $(5, 6)$, $(8, 2)$, $(7, 9)$, and $(9, 0)$.

Check your answers on pages 102 and 103 in the Appendix.

Appendix

Glossary
Answer Key
Cut-Out Learning Aids



Glossary

coordinate plane: a grid

coordinates: the numbers in an ordered pair

flip: a motion in which an object or figure is flipped over a fixed line called the flip line

flip line: the fixed line about which an object or figure is flipped

grid: a surface ruled into squares using horizontal and vertical lines

line of symmetry: the centre line about which a geometric figure can be folded so the two halves of the figure match exactly

line symmetry: the property in which one-half of a shape can be flipped onto the other half so the two halves match exactly

ordered pair: two numbers used to locate a point in the coordinate plane

origin: the starting point of the coordinate plane; the coordinate $(0, 0)$

point symmetry: the property in which a shape matches with its original position more than once in a full turn

point of symmetry: the point about which a figure can be turned so it matches the original position

slide: a motion in which an object or figure changes position by moving in a straight line

tessellation: a set of shapes that covers a whole surface with gaps or overlaps

turn: a motion in which an object or figure rotates about a fixed point called the turn centre

turn centre: a point about which an object or figure rotates

Answer Key

Lesson 1: Slides, Turns, and Flips

Activity 1

1. a. **Ship 1:** 2 km west, 5 km north, 3 km west, 2 km north, 2 km east, 6 km north, 1 km west, 3 km north, 3 km east

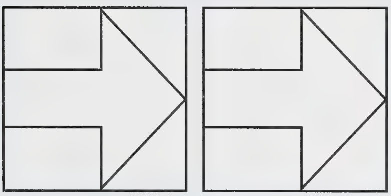
   Ship 2: 15 km north.

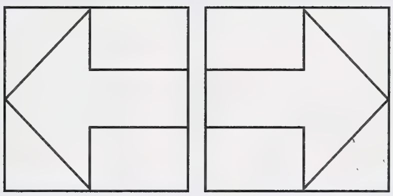
   Ship 3: 2 km east, 5 km north, 3 km east, 2 km north, 2 km west, 6 km north, 1 km east, 3 km north, 3 km west

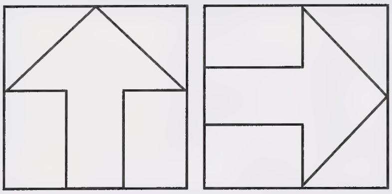
   b. The course for Ship 2 was easiest to describe. The ship travelled north in a straight line without making any turns.

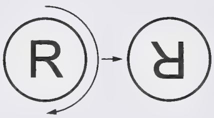
   c. Both ships travelled north, but whenever one of the ships travelled west, the other ship travelled east. All of the distances were the same.

   d. Ship 2 would arrive first because it travelled the shortest distance. Ships 1 and 3 would arrive later than Ship 2, but at the same time as each other. They travelled farther than Ship 2, but they travelled the same distance as each other.

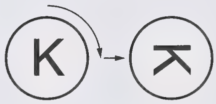
2. a. 

   b. 

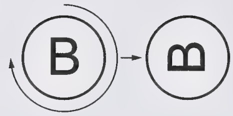
3. 

4. a. 

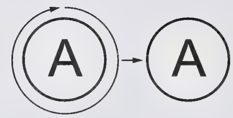
$\frac{1}{2}$ turn

b. 

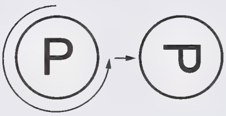
$\frac{1}{4}$ turn

c. 

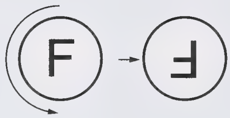
$\frac{3}{4}$ turn

d. 

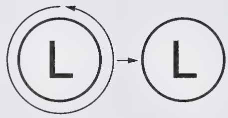
a full turn

5. a. 

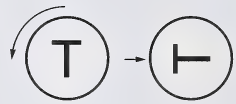
$\frac{3}{4}$ turn

b. 

$\frac{1}{2}$ turn

c. 

a full turn

d. 

$\frac{1}{4}$ turn

Activity 2

1. Figure A has two lines of symmetry.

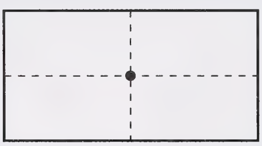


Figure B doesn't have line symmetry.

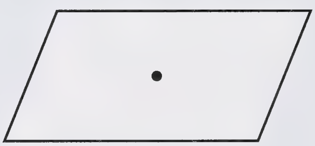


Figure C doesn't have line symmetry.

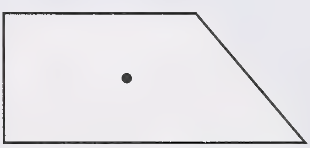


Figure D has three lines of symmetry.

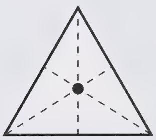


Figure E has six lines of symmetry.

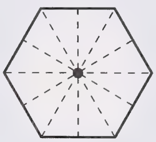
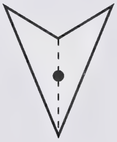


Figure F has one line of symmetry.



2. Figure A has point symmetry. The shape will fit onto itself twice in a full turn.

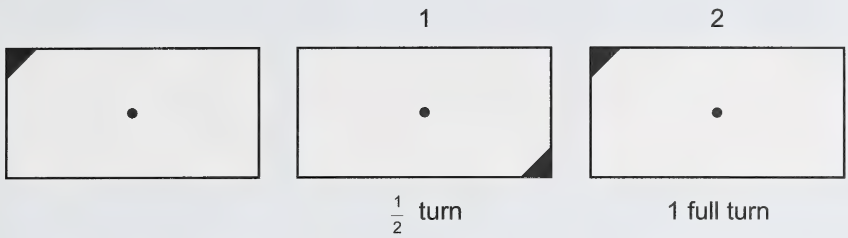


Figure B has point symmetry. The shape will fit onto itself twice in a full turn.

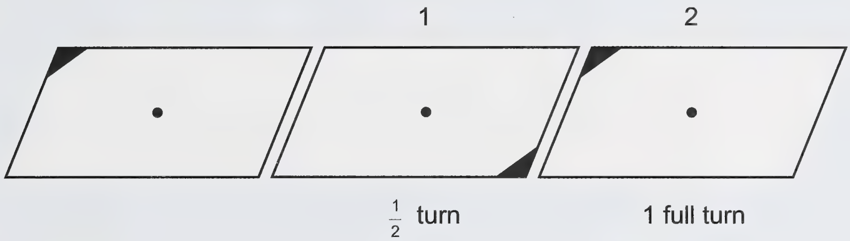


Figure C doesn't have point symmetry.

Figure D has point symmetry. The shape will fit onto itself three times in a full turn.

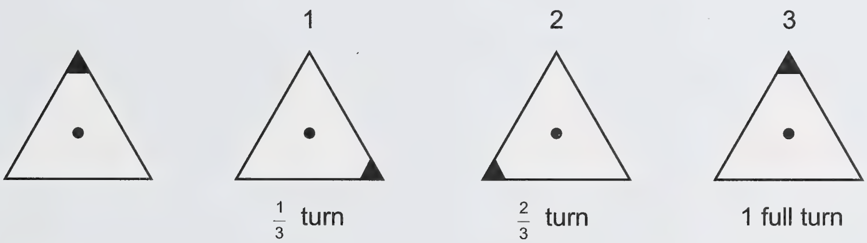


Figure E has point symmetry. The shape will fit onto itself six times in a full turn.

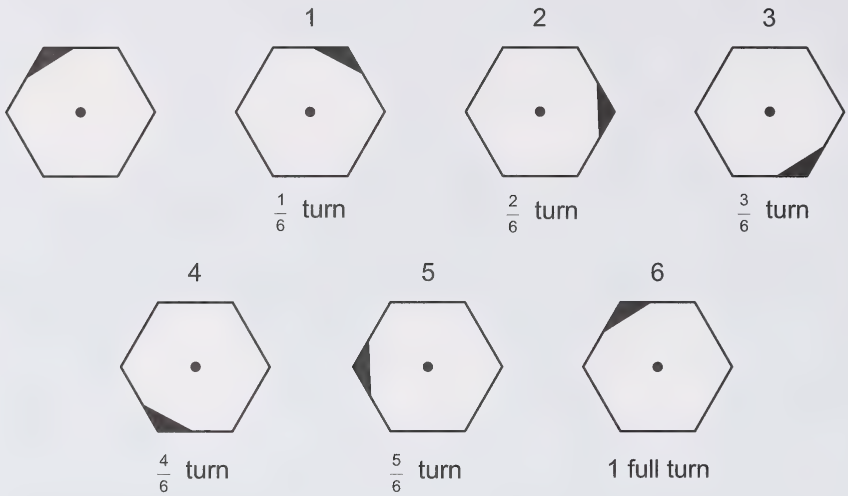


Figure F doesn't have point symmetry.

Activity 3

1. a. Each word in the message is spelled from left to right.
   b. Each word in its reflection is spelled backward, from right to left.

2. a. The letters W, H, A, T, O, Y, U, I, and M look the same as their reflections.
   b. The letters D, S, E, N, and R have reflections that are backward.

3. a. The letters that have a vertical line of symmetry are A, H, I, M, O, T, U, V, W, X, and Y.
   b.

4. a. The letters that have a horizontal line of symmetry are B, C, D, E, H, I, K, O, and X.

   b.

5. The letters that have both vertical and horizontal lines of symmetry are H, I, O, and X.

6. The letters that have point symmetry are H, I, N, O, S, X, and Z.

7. The letters that have both line symmetry and point symmetry are H, I, O, and X.

8. The letters that have neither line nor point symmetry are F, G, J, L, P, Q, and R.

Activity 4

1. a. I see a turn motion.
   b. I see a turn motion.

2. a. quarter turn, counterclockwise
   b. quarter turn, clockwise
   c. half turn, clockwise
   d. half turn, counterclockwise
   e. quarter turn, counterclockwise
   f. quarter turn, clockwise
   g. quarter turn, clockwise
   h. quarter turn, counterclockwise

3. a. quarter turn, clockwise
   b. quarter turn, counterclockwise
   c. half turn, counterclockwise
   d. half turn, clockwise
   e. quarter turn, clockwise
   f. quarter turn, counterclockwise
   g. quarter turn, counterclockwise
   h. quarter turn, clockwise

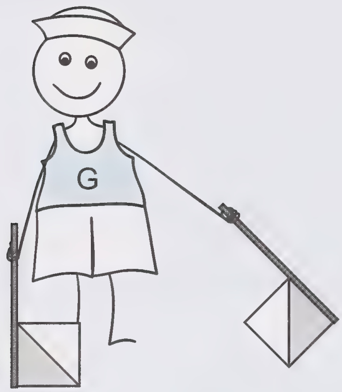
4. The turn changes described in each part of questions 3 and 4 are the same, but the turn motion is in the opposite direction.

5. a. a flip with a horizontal flip line through the signaller's waist
   b. a flip with a horizontal flip line through the signaller's waist

6. **a.** The signal for the letter A is left hand down, right hand low.

   b. The signal for the letter G is left hand low, right hand down.

   c.



7. **a.** The signal for the letter R is left hand out, right hand out.

   b. a flip (with a vertical flip line through the signaller)

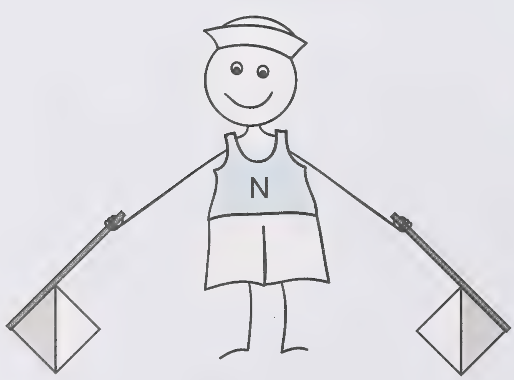
   c. To signal the letter D immediately after signalling the letter R, the signaller can turn both hands a quarter turn clockwise or both hands a quarter turn counterclockwise.

8. **a.** The signal for the letter U is left hand high, right hand high.

   b. a flip (with a vertical flip line through the signaller)

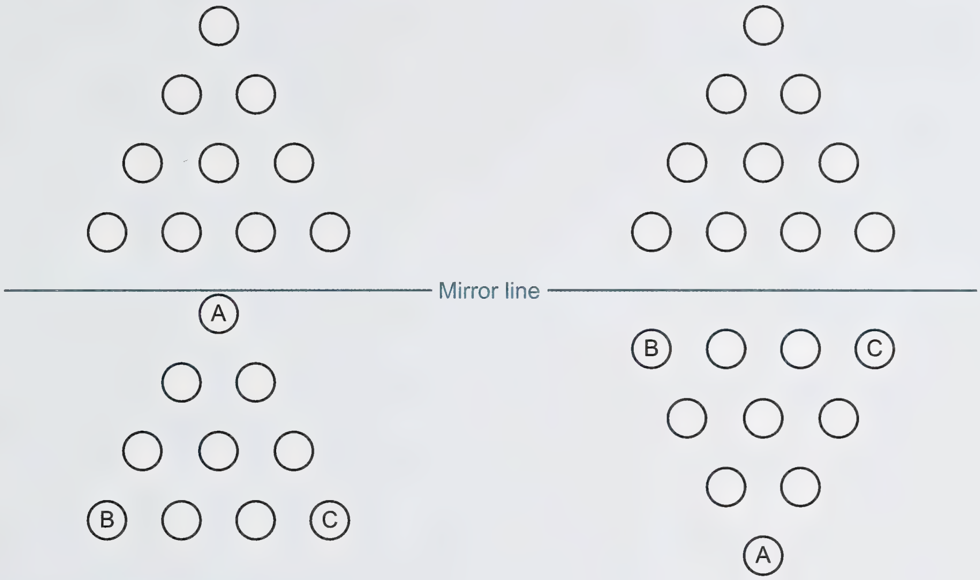
   c. The signal for the letter N is left hand low, right hand low.

   d.



Challenge Activity

Pins A, B, and C are moved as shown.



Lesson 2: Tessellations

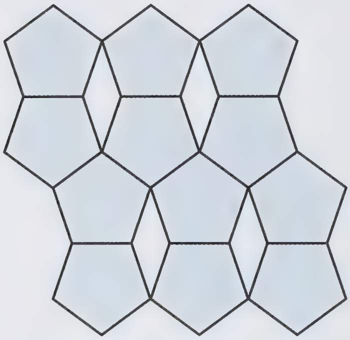
Activity 1

1. a. The sides in each of the pattern blocks are the same length, except for the longest side of the trapezoid. That side is twice as long as the other sides.

   b. All six of the shapes will tessellate as Mr. Singh wants.

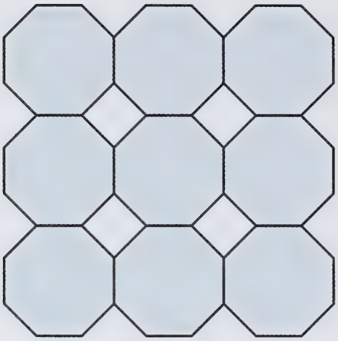
2. The triangle, the square, and the hexagon are regular polygons.

3. a. Tiling with the pentagon



No, the pentagon will not tessellate.

Tiling with the octagon

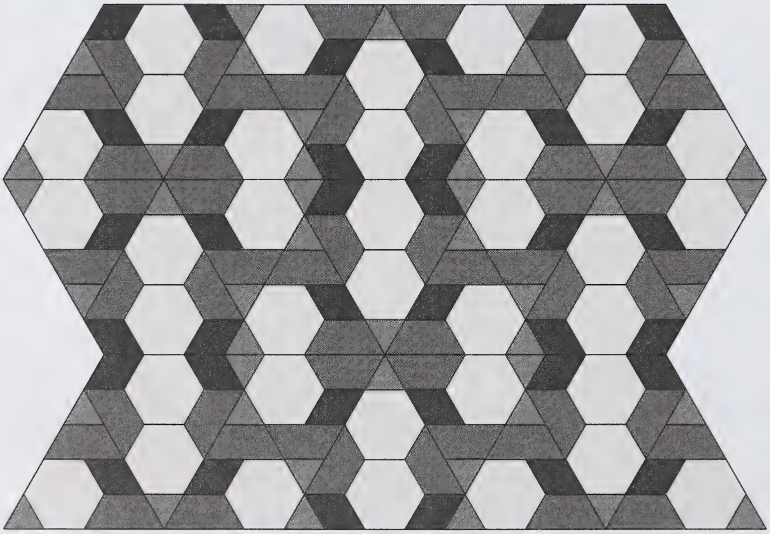


No, the octagon will not tessellate.

b. The gaps between the pentagons can be filled with the tan rhombuses. The gaps between the octagons can be filled with the orange squares.

4. Answers will vary. A sample answer is given.

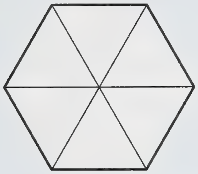
A tessellation using pattern blocks that is at least 25 cm by 25 cm in area is shown. (**Note:** The graphic is not to scale.)



Activity 2

1. Six walls are needed for one cell.

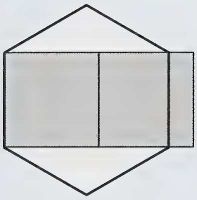
2. a.



b. The bees need to make 12 walls to store the same amount of honey as they can in one hexagonal cell.

c. The bees use hexagonal cells rather than triangular cells because they can make the same amount of storage space with fewer walls.

3. a.

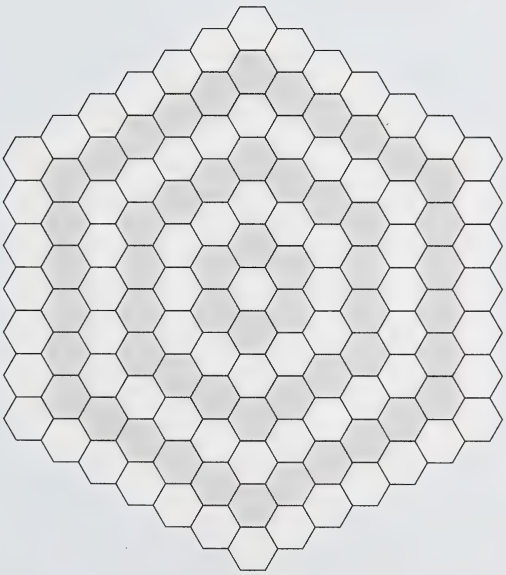


b. The area covered by two squares is less than the area covered by one hexagon.

c. The bees need seven walls to make two square cells.

d. The bees use hexagonal cells rather than square cells because they can make more storage space with fewer walls.

4. a.



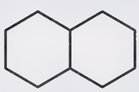
b.

	Day						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Total Number of Rings in Honeycomb at End of Day	1	2	3	4	5	6	7
Number of Cells in Ring Built That Day	1	6	12	18	24	30	36
Total Number of Cells in Honeycomb	1	7	19	37	61	91	127

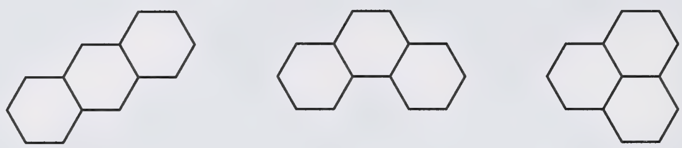
c. After the second day, the number of cells in the ring built each day increases by 6.

d. There are 127 cells in the honeycomb at the end of one week.

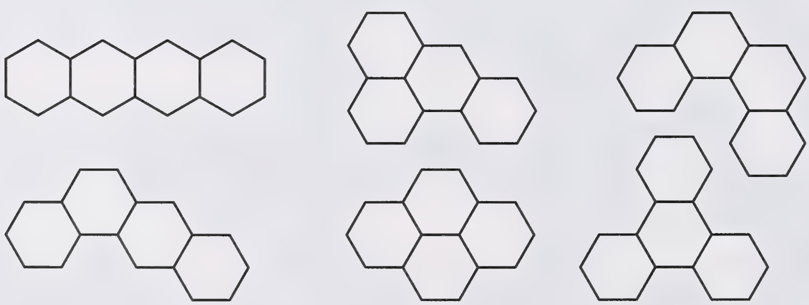
5. a.



b.

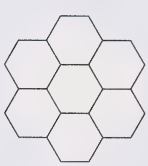


c.

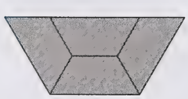


Activity 3

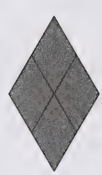
1.



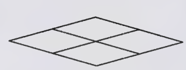
Not possible with hexagons



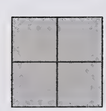
Red trapezoid



Blue rhombus

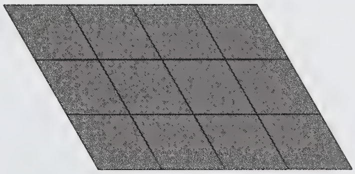


Tan rhombus

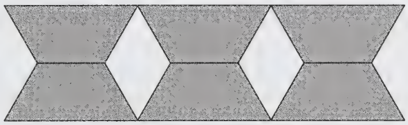


Square

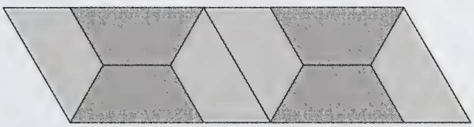
2. a. The blue rhombus can tessellate a surface using only slides.



b. The red trapezoid can’t tessellate a surface using only horizontal and vertical flips.



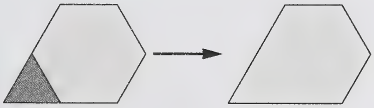
However, if a non-parallel side is also used as a flip line, the red trapezoid can tessellate a surface.



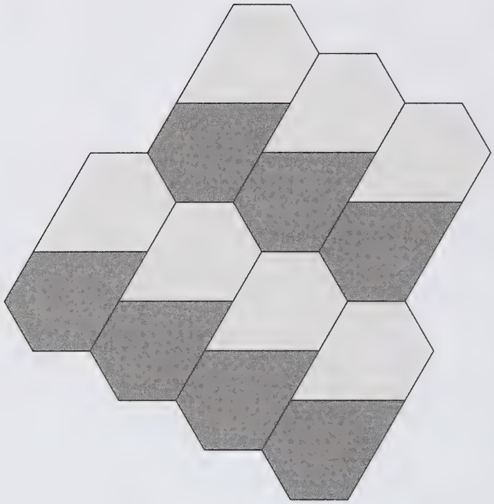
c. Using only turns, the tan rhombus tessellates about a point. However, slides are also needed for the tan rhombus to tessellate a surface.

3. Answers will vary depending on the blocks you use. A sample answer is given.

a. A new shape was made by taping together a yellow hexagon and a green triangle.

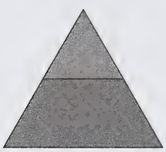


b.

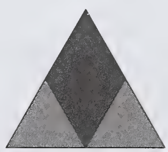


4. Answers will vary. Sample answers are given:

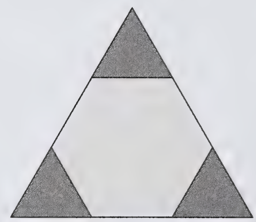
a.



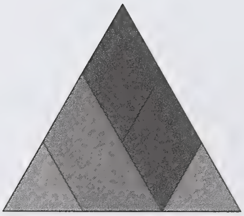
b.



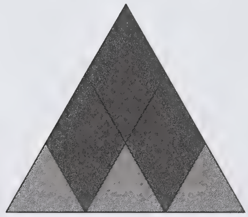
c.



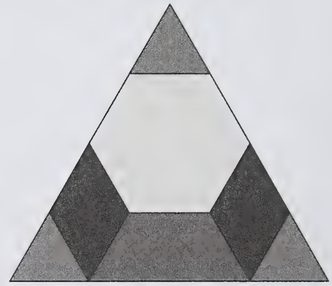
d.



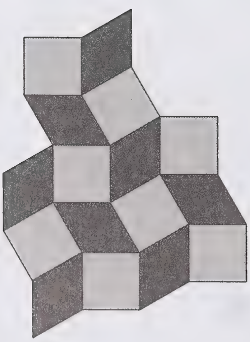
e.



f.

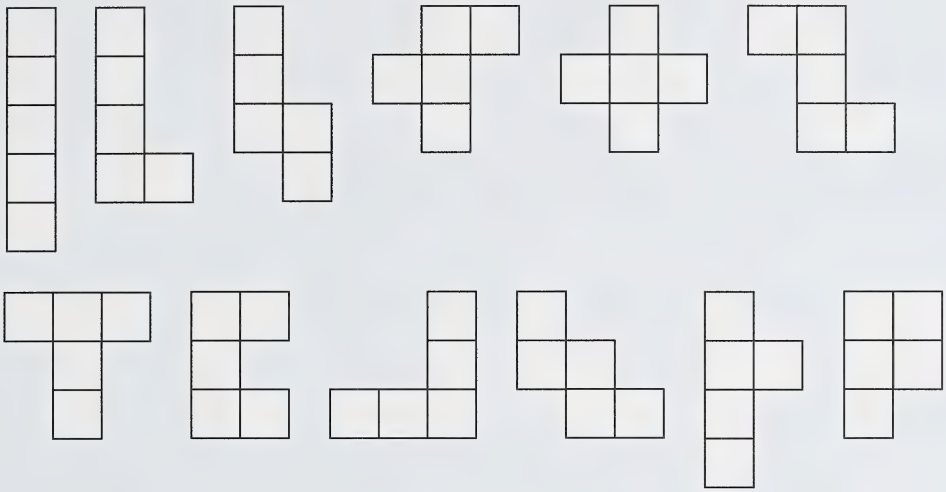


5.

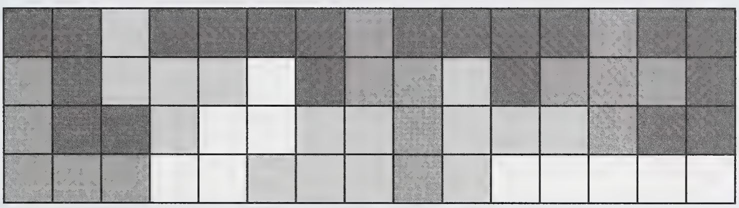


Challenge Activity

1. The 12 possible pentominoes are shown.



2. There are 2339 different ways to make a 6 by 10 rectangle! It's also possible to make a 5 by 12 rectangle or a 4 by 15 rectangle. A sample answer is given. You may have to flip some of your pieces over to make a rectangle.



Lesson 3: Plotting Points

Activity 1

1. The first number in the ordered pair tells how far to the right to slide from the origin. The second number in the ordered pair tells how far up to slide from the origin. Alkaid's ordered pair tells you that it is located 2 units to the right and 3 units up from the origin.

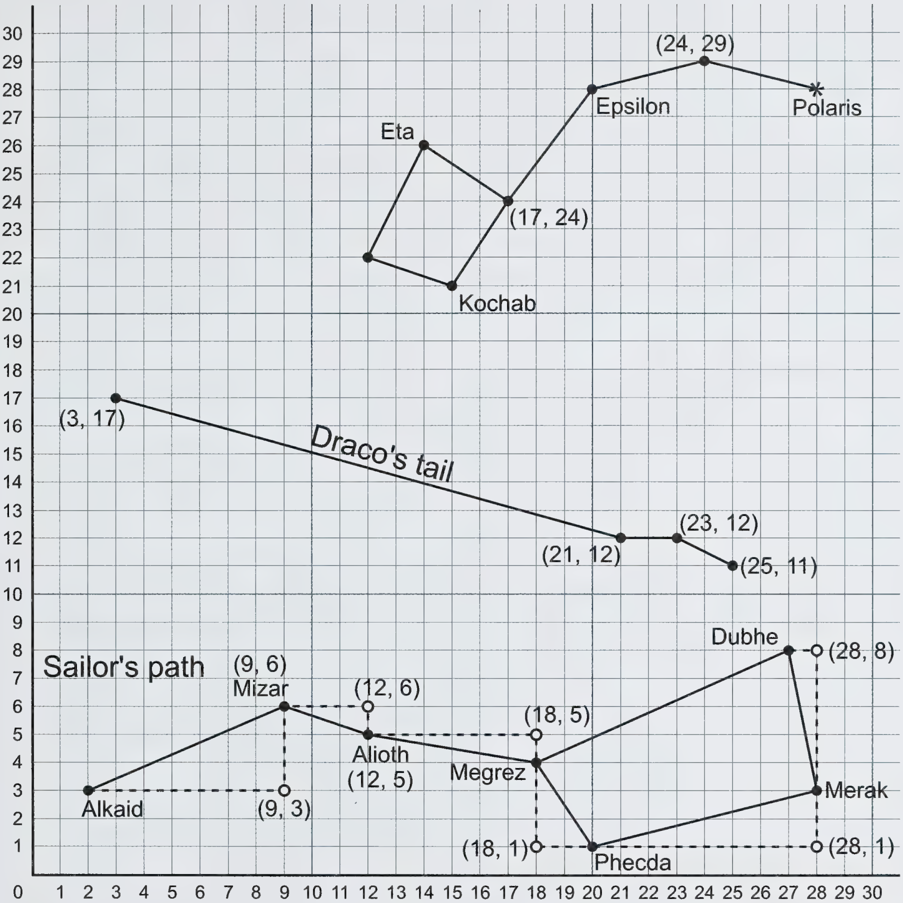
2. a. The first number in Mizar's ordered pair is 9. To find this number, follow the vertical line down to the bottom of the grid. This tells that Mizar is 9 units to the right of the origin.

   b. The second number in Mizar's ordered pair is 6. To find this number, follow the horizontal line across to the number at the left of the grid. This tells that Mizar is 6 units above the origin.

3.

Name of Star	Ordered Pair	Description (Slide from Origin)
Alioth	(12, 5)	12 right and 5 up
Alkaid	(2, 3)	2 right and 3 up
Dubhe	(27, 8)	27 right and 8 up
Epsilon	(20, 28)	20 right and 28 up
Eta	(14, 26)	14 right and 26 up
Kochab	(15, 21)	15 right and 21 up
Megrez	(18, 4)	18 right and 4 up
Merak	(28, 3)	28 right and 3 up
Mizar	(9, 6)	9 right and 6 up
Phecda	(20, 1)	20 right and 1 up
Pherkad	(12, 22)	12 right and 22 up
Polaris	(28, 28)	28 right and 28 up
Yildum	(24, 29)	24 right and 29 up
Zeta	(17, 24)	17 right and 24 up

4. and 5. The answers to questions 4 and 5 are shown below.



6. To move from one star to the next, you needed to make two slides along the grid lines. You needed to make one horizontal slide (to the left or right) and one vertical slide (up or down).

   It is customary to list the horizontal slide (left or right) before you list the vertical slide (up or down). For example, to get from Alkaid to Polaris along the grid lines, slide 26 units to the right and slide 25 units up.

7. No. To move between most pairs of stars within the Big Dipper, you need to make both a horizontal slide and a vertical slide, but there is an exception. To move from Alkaid to Merak, you only need to slide to the right, since they are on the same horizontal line.

8. No. To move along the grid lines, from most stars in the Big Dipper to any star in the Little Dipper, you need to make both a horizontal slide and a vertical slide, but there are exceptions. To move from Alioth to Pherkad, or from Phecda to Epsilon, or from Merak to Polaris, you only need to slide up, since they are on the same vertical line.

9. You can tell the number of slides needed to move between any two stars just by looking at their coordinates. If the first number in the ordered pair for both stars is the same, then you only have to make one slide, either up or down the vertical grid line. If the second number in the ordered pair for both stars is the same, then you only have to make one slide, either left or right on the horizontal grid line.

10. **a.** Pherkad and Kochab appear to be closest to one another.

    b. To go from Pherkad to Kochab, you slide 3 units right and 1 unit down. That is a total distance of 4 grid line units.

11. Epsilon appears to be closer to Zeta. To go from Epsilon to Zeta, you slide 3 units left and 4 units down. That is a total distance of 7 grid line units. To go from Epsilon to Eta, you slide 6 units left and 2 units down. That is a total distance of 8 grid line units.

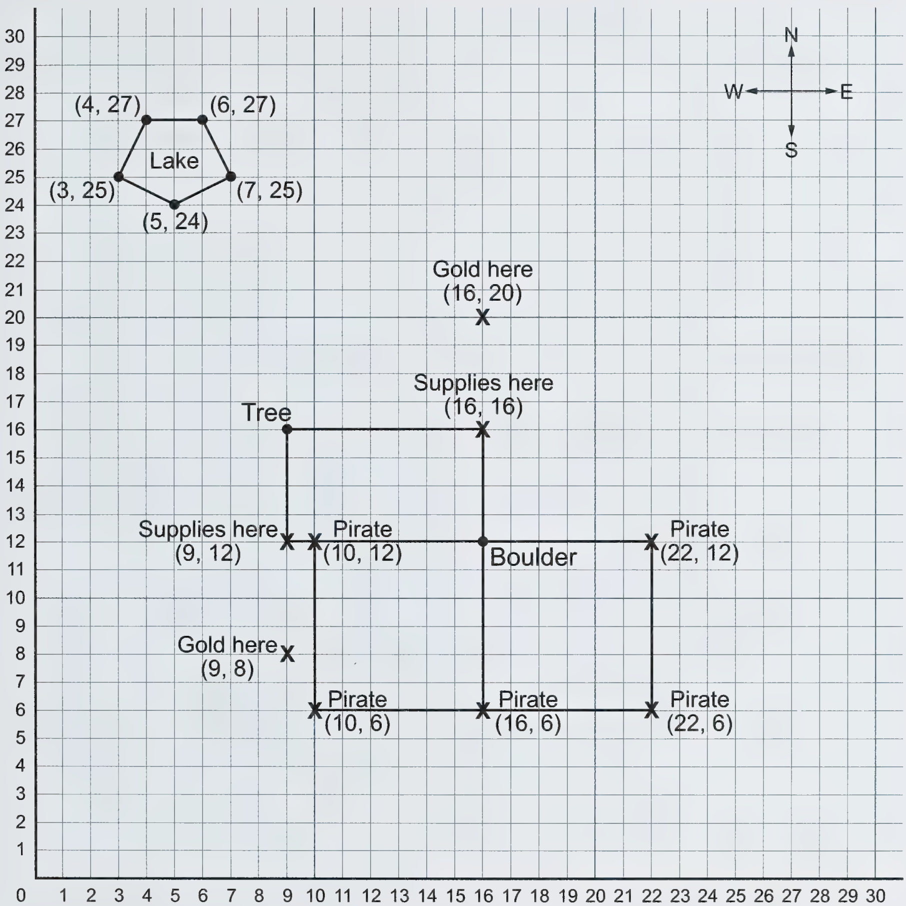
12. **a.** Eta and Kochab appear to be the same distance from Zeta. $(3+2=5$ grid line units$)$

    b. The coordinates of Pherkad would have to be $(12, 23)$.

Activity 2

The following grid contains answers to questions 1.b., 2, 3, and 4.a.

SHADOW ISLE



1. a. The coordinates for the tree are $(9, 16)$. The coordinates for the boulder are $(16, 12)$.

b. See the above grid for the points where the gold is buried.

c. Answers will vary. Sample answers are given.

- Clue: **Get N**orman, the tree and boulder on Shadow Isle.
  The N in Norman stands for **n**orth, which means the treasure is at $(16, 20)$.

- Clue: Captain Quinn **Gets** the tree and boulder on Shadow Isle.
  The S in Gets stands for **s**outh, which means the treasure is at $(9, 8)$.

2. The coordinates of the two corners of the rectangle are $(9, 12)$ and $(16, 16)$. See the grid on the previous page for the plotted points.

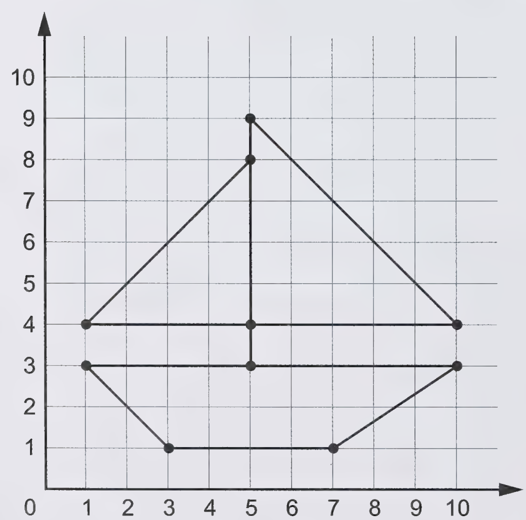
3. The three coordinates where the treasure was buried could be either $(16, 6)$, $(22, 6)$, and $(22, 12)$; or $(16, 6)$, $(10, 6)$, and $(10, 12)$. See the grid on the previous page for the plotted points.

4. See the grid on the previous page for the plotted and connected points.

5. The ordered pairs are $A(20, 24)$, $B(24, 24)$, $C(26, 24)$, $D(21, 21)$, and $E(25, 21)$.

6. The message is “Buried by the oak tree.”

7.



8. Answers will vary. A sample answer is given.

- Form a square by connecting the following points: $(1,1)$, $(9,1)$, $(9,9)$, and $(1,9)$.
- Connect $(5,5)$ to each of the following points: $(1,1)$, $(1,9)$, $(9,9)$, and $(7,3)$.
- Connect (5, 1) to points $(3,3)$ and $(7,3)$.
- Connect $(7,3)$ to points $(9,5)$ and $(7,7)$.

Activity 3

1. a. It is not possible to plot $(4,12)$ and $(20,8)$ without extending the grid. The number 12 in the ordered pair $(4,12)$ means that the point is 12 units above the origin, but the grid only goes up to 10 units above the origin. The number 20 in the ordered pair $(20,8)$ means that the point is 20 units to the right of the origin, but the grid only goes 10 units to the right of the origin.

   b. The greatest possible first number in its ordered pair is 10 because the grid only goes 10 units to the right of the origin.

   c. The greatest possible second number in its ordered pair is 10 because the grid only goes up to 10 units above the origin.

2. a. Both Grid A and Grid B are 10 by 10 arrays with squares that are the same size.

   b. On Grid A, each square has sides which are 1 unit long. On Grid B, each square has sides which are 2 units long.

3. a. For Grid A, the ordered pair in which both the first number and the second number are the least possible is $(0,0)$. This point is the origin, located at the bottom left corner of the grid.

   b. For Grid A, the ordered pair in which both the first number and the second number are the greatest possible is $(10,10)$. This point is located at the top right corner of the grid.

4. a. For Grid B, the ordered pair in which both the first number and the second number are the least possible is $(0, 0)$. This point is the origin, located at the bottom left corner of the grid.

   b. For Grid B, the ordered pair in which both the first number and the second number are the greatest possible is $(20, 20)$. This point is located at the top right corner of the grid.

5. a. The answers for questions 3.a. and 4.a. are the same. The ordered pairs for both Grid A and Grid B is the origin $(0, 0)$.

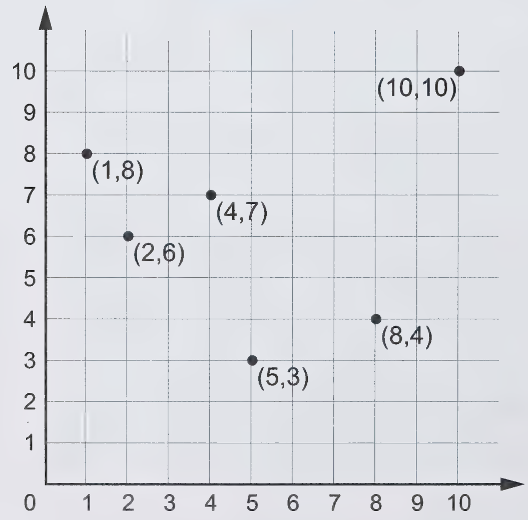
   b. Both numbers in the ordered pair for Grid B are twice as large as the numbers in the ordered pair for Grid A.

6. a. There are 100 shaded squares on Grid A, but only 25 shaded squares on Grid B. This means that there are four times as many shaded squares on Grid A as there are on Grid B.

   b. The ordered pairs for the points shown on Grid B are $(1, 8)$, $(2, 6)$, $(4, 7)$, $(5, 3)$, $(6, 14)$, $(8, 4)$, and $(15, 5)$.

   c. The other ordered pairs that can be plotted on Grid A are $(1, 8)$, $(2, 6)$, $(4, 7)$, $(5, 3)$, and $(8, 4)$. These are shown on the following grid.

Grid A

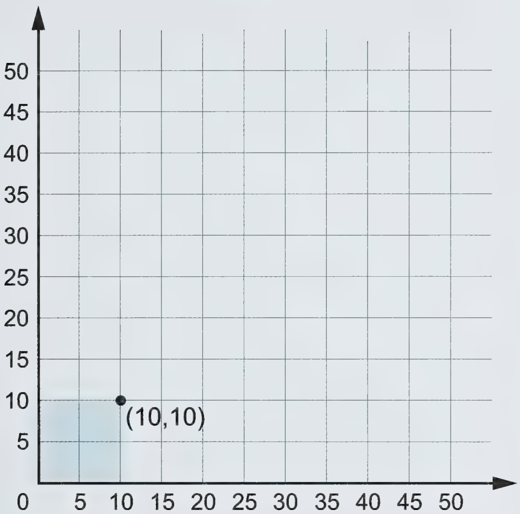


d. An advantage of using such a scale is that it allows you to plot more points.

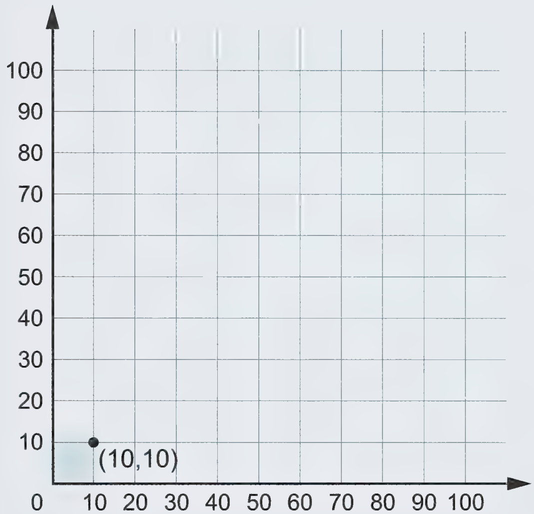
e. A disadvantage of using such a scale is that some of the points do not sit on the grid lines. The points may seem to be more crowded because they are closer together.

7. a.

Grid C



Grid D



b. As the grid scales are changed to larger multiples, you can plot points with larger coordinates, but the points get closer together.

c. For Grid C, the ordered pair in which both the first number and the second number are the greatest possible is $(50, 50)$.

d. For Grid D, the ordered pair in which both the first number and the second number are the greatest possible is $(100, 100)$.

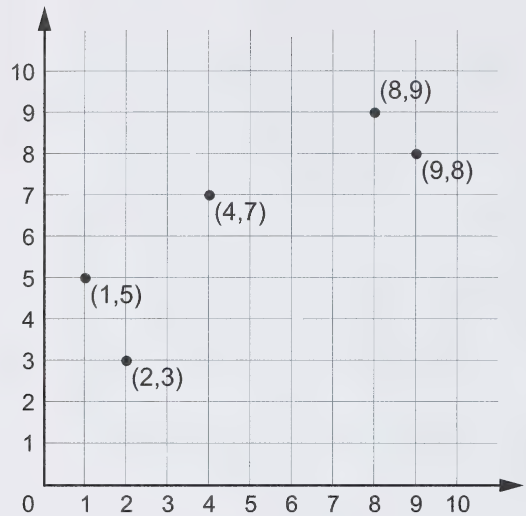
8. It would be best to use Grid B because the points would be less crowded than if they were plotted using Grid C or Grid D. It is also easier to estimate where the points between the lines should be placed.

9. a. The largest number in the ordered pairs is 9. I can plot that point on Grid A.I will use Grid A so that the points will be farther apart than if I used any of the other grids.

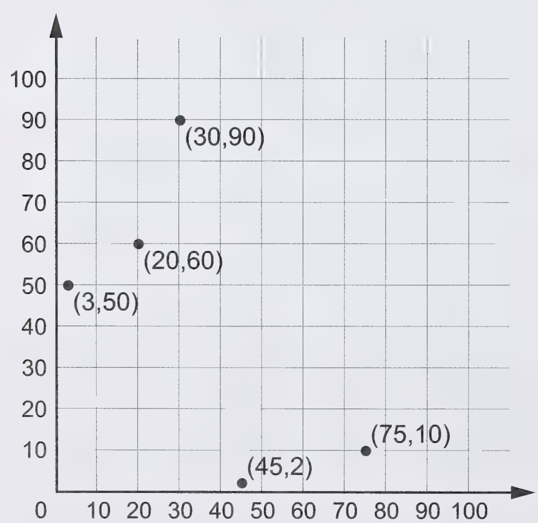
b. The largest number in the ordered pairs is 90. I cannot not plot that point on Grid A, Grid B, or Grid C, but I can plot it on Grid D. I will use Grid D.

c. The largest number in the ordered pairs is 30. I cannot not plot that point on Grid A or on Grid B, but I can plot it on Grid C or on Grid D. I will use Grid C so that the points will be farther apart than if I used Grid D.

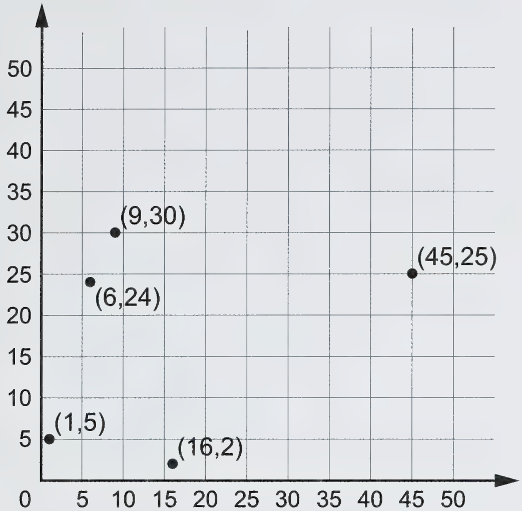
10. a.



b.



c.



Challenge Activity

1. The nine points are shown on the grid.

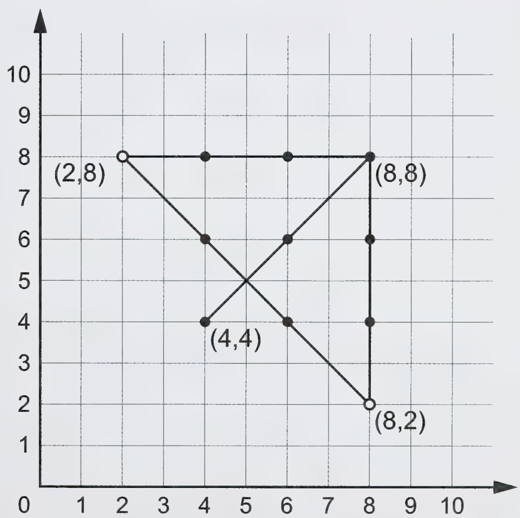
2. Answers will vary. A sample answer is given.

First line: Begin at $(4, 4)$ and connect it to $(8, 8)$.

Second line: Connect $(8, 8)$ to $(2, 8)$.

Third line: Connect $(2, 8)$ to $(8, 2)$.

Fourth line: Connect $(8, 2)$ to $(8, 8)$.



Keystrokes

1. a.

Keypad	0	1	2	3	4	5	6	7	8	9
Display	0	1	2	3	4	5	6	7	8	9

b. The calculator display digits that have point symmetry are 0, 1, 2, 5, and 8.

c. The palindromes that have point symmetry are 11 and 20 002.

d. If all the digits in the palindrome have point symmetry, then the palindrome itself has point symmetry.

e. All possible three-digit palindromes using the digits 1, 2, and 8 that have point symmetry are 111, 222, 888, 121, 181, 212, 282, 818, and 828.

f. The numbers that are palindromes that have point symmetry are 852 258 and 1 000 001.

g. Answers will vary. Sample answers are given: $11+11=22$, $22+11+22=55$, and $11+11+11+22+11+11+11=88$.

2. **a.** The digit 6 does not have turn symmetry.

b. When you turn 6 upside down, you see 9.

c. The digit 9 does not have turn symmetry.

d. When you turn 9 upside down, you see 6.

e. The display digit for 6 is the half-turn image of the display digit for 9 and the display digit for 9 is the half-turn image of the display digit for 6.

f. When you turn the calculator upside down, you see the numbers shown.

Number Displayed	69	96	66	99	626	959	689	5695
Number Seen Upside Down	69	96	99	66	929	656	689	5695

g. To display a multi-digit number using the digits 6 and 9 that has point symmetry:

- You must have the same number of 6s as 9s in the number.
- You may also use any or all of the digits 0, 1, 2, 5, and 8.
- Write a number that would be a palindrome if 6 and 9 were the same digit.

Examples include the calculator displays of 1 065 901, 1 660 991, 506 905, 268 892, and 696 969.

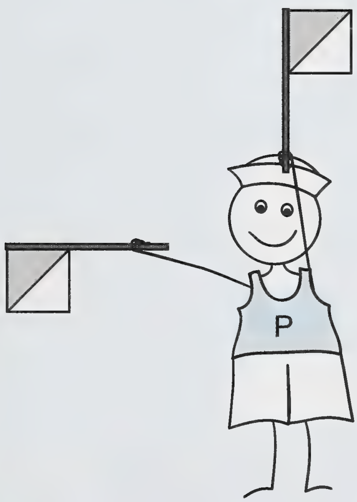
Review

1. Slide 3.5 m right, slide 3 m down, slide 2 m right, slide 1 m up, slide 3 m right, slide 2 m up, slide 1.5 m left.

2. **a.** The signal for the letter J is left hand out, right hand up.

   b. The signal for the letter P is left hand up, right hand out.

   c.

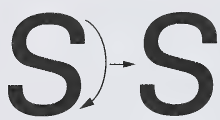


3. **a.**

b. The T and A look the same.

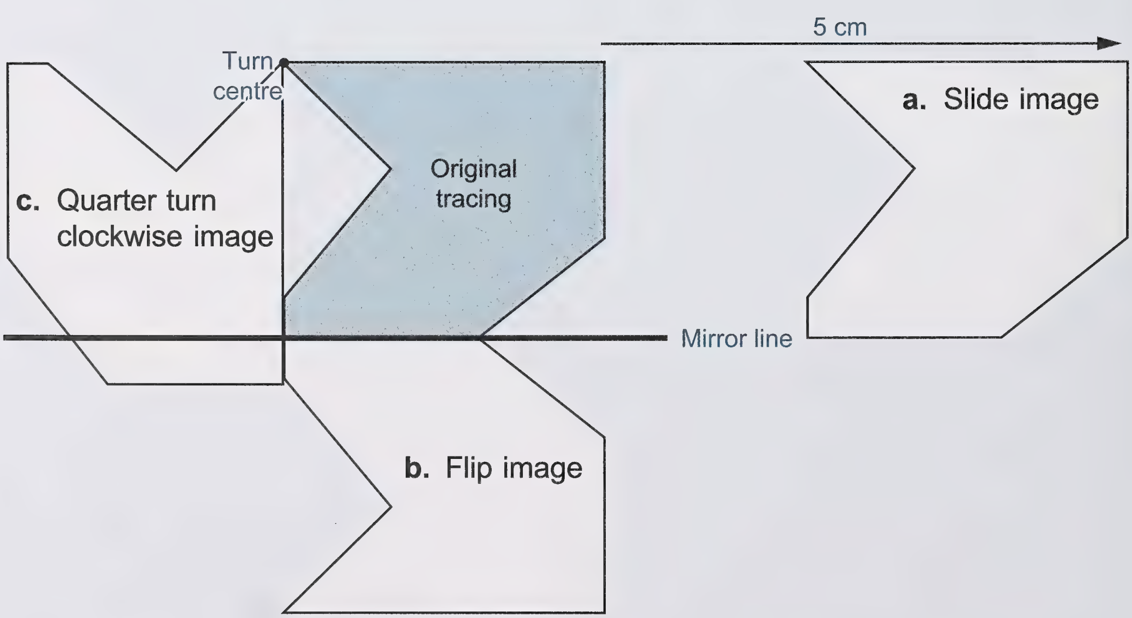
c. The E has a horizontal line of symmetry.

The S has half turn symmetry.



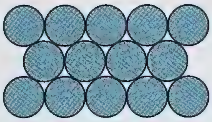
The R has no symmetry.

4.

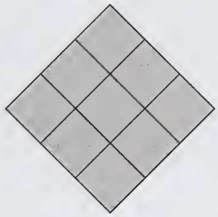


5. **Textbook, page 232, Practise Your Skills**

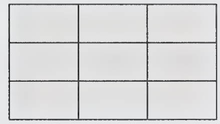
A. It does not tessellate.



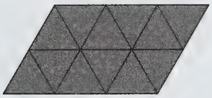
B. It tessellates.



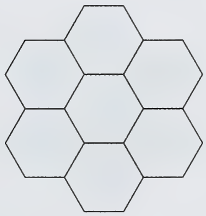
C. It tessellates.



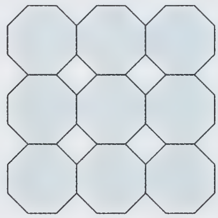
D. It tessellates.



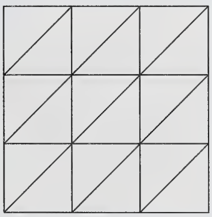
E. It tessellates.



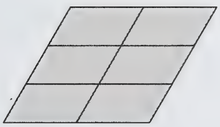
F. It does not tessellate.



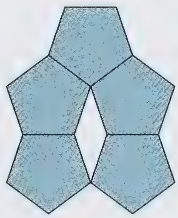
G. It tessellates.



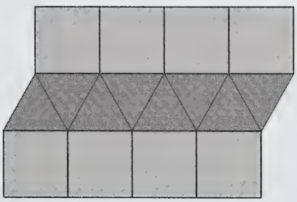
H. It tessellates.



I. It does not tessellate.



6. Answers will vary. A sample answer is given.

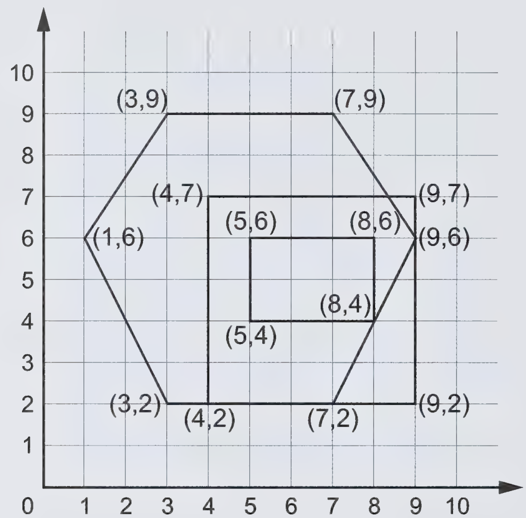


7. The answers are shown on the grid that follows.

   a. The corners of the hexagon are $(3, 9)$, $(7, 9)$, $(9, 6)$, $(7, 2)$, $(3, 2)$, and $(1, 6)$.

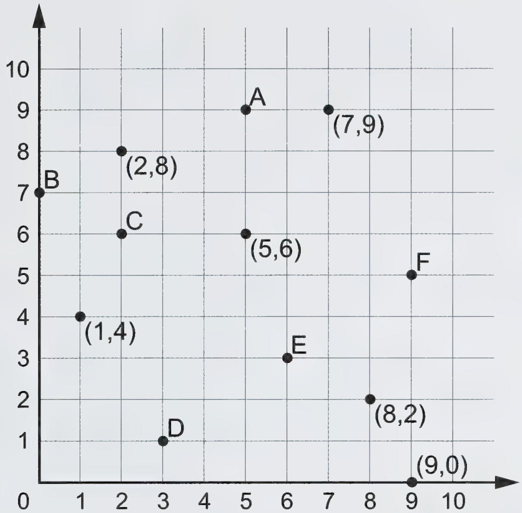
   b. The corners of the square are $(9, 7)$, $(4, 2)$, $(4, 7)$, and $(9, 2)$.

   c. The corners of the largest possible rectangle inside the square are $(5, 6)$, $(8, 6)$, $(8, 4)$, and $(5, 4)$.



8. a. The ordered pairs for each of the points shown on the grid are A$(5, 9)$, B$(0, 7)$, C$(2, 6)$, D$(3, 1)$, E$(6, 3)$, and F$(9, 5)$.

b. The following points are shown on the grid $(1, 4)$, $(2, 8)$, $(5, 6)$, $(8, 2)$, $(7, 9)$, and $(9, 0)$.



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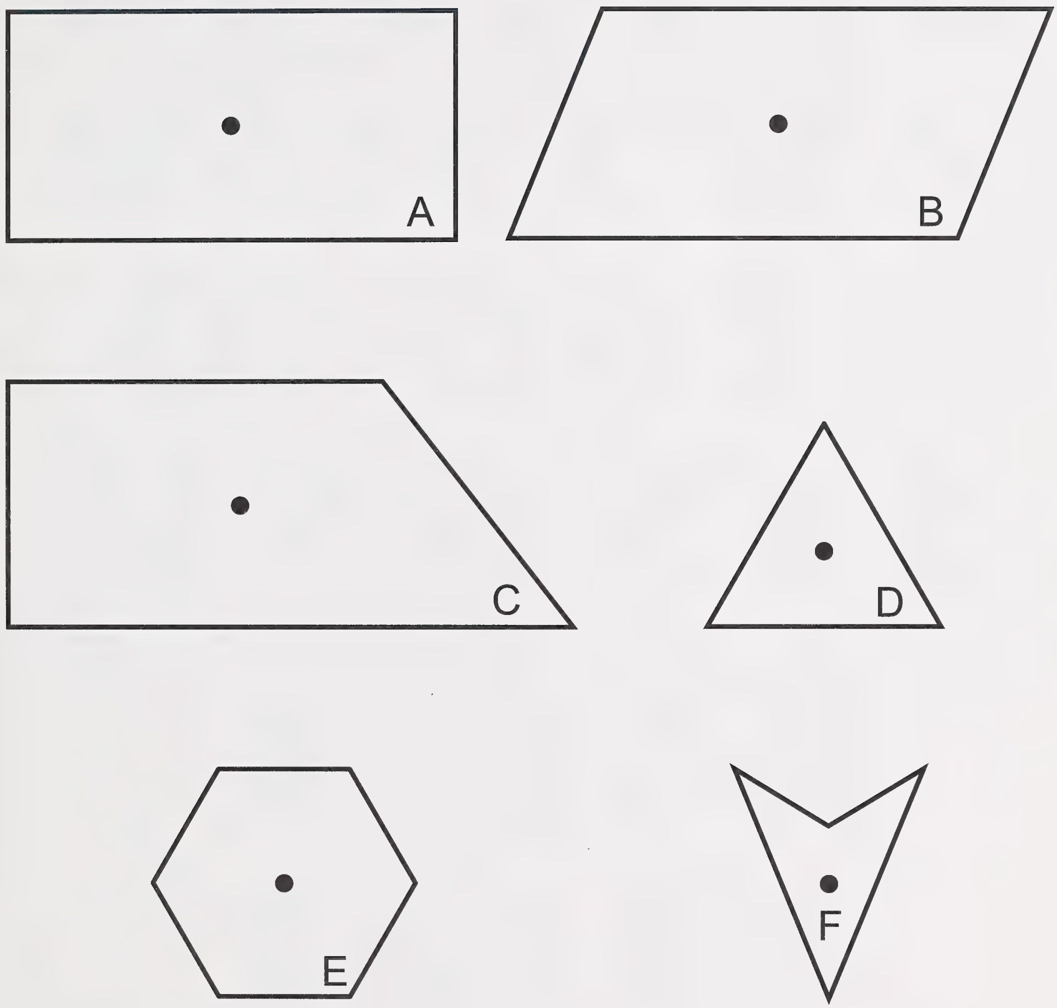


Letters and Numerals

A B C D E F G

H I J K L M N

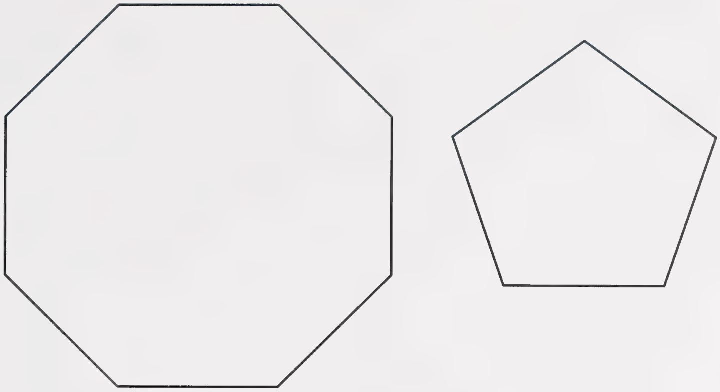
O P Q R S T

U V W X Y Z

0 1 2 3 4

5 6 7 8 9

Regular Pentagon and Regular Octagon



Hexagonal Grid Paper

1-cm Grid Paper